GEF concept note on sustainable bagasse based cogenerated power distribution by Shri Tatyasaheb Kore Warana Sahakari Sakhar Karkhana Ltd., Warananagar, District Kolhapur, Maharashtra

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Shri Tatyasaheb Kore Warana SSK Ltd — Tel: 02328-24081/87
Warananagar 416 113, Maharashtra — Fax: 02328-24090
and
PRG Technology — Tel: 020-5410321
D-2, Chandrakamal, 22 Modern Colony — Fax: 020-5651086
Kothrud, Pune - 411 038

Project team

Project Advisor:	Dr Leena Srivastava
Principal Investigator:	Mr I H Rehman Mr G Padmanabhan
TERI Team members:	Dr Y P Abbi Mr Asim Mirza
	And
	PRG Technologies Members

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List of abbreviations

A.C. - Alternating Current
Ah - Ampere Hour
ata - Atmosphere (pressure unit)
BOD - Biological Oxygen Demand
CC - Climate Change
CO_2 - Carbon Dioxide
COD - Chemical Oxygen Demand
Co-gen - Co-generation
Cum - Cubic Meter
D.C. - Direct Current
DCS - Distributed Control System
Deg C - Degrees Centigrade
DM - Demineralised (water)
DPR - Detailed Project Report
EPS - Engineering and Procurement Services
ERC - Electricity Regulatory Commission
GEF - Global Environment Facility
GHG - Green House Gases
GOM - Government of Maharashtra
GOI - Government of India
HP - Horse Power
hr - Hour
Hz - Hertz
kA - Kilo Ampere
KLPD - Kilo Litres per Day
kV - Kilo Volt
kVA - Kilo Volt Ampere
kW - Kilo Watt
kWh - Kilo Watt Hour
LP - Low Pressure
MCC - Motor Control Centre

List of abbreviations

MCM - Million cubic meters
MCR - Maximum Continuous Rating (Boiler)
MERC - Maharashtra Electricity Regulatory Commission
mg - Milli gram
mm - Milli Meter
MoEF - Ministry of Environment and Forests,
MPCB - Maharashtra Pollution Control Board
MSEB - Maharashtra State Electricity Board
MT - Metric Tons
MU - Million Units
MVA - Million Volt Amperes
MW - Mega Watts
N.cum - Normal Cubic Meter
NGR - Normal Grounding Resistor
NO_x - Nitrogen Oxides
O&M - Operation and Maintenance
O_2 . Oxygen
OP - GEF Operational Program
P&T - Post and Telegraph
pf - Power Factor
pH - Hydrogen Ion Concentration
PLC - Programmable Logic Controller
PMC - Project Management Cell
PRDS - Pressure Reducing and Desuperheating Station
PRG - PRG Technologies
PVC - Poly Vinyl Chloride
REG - Rural Energy Group, TERI
rpm - Revolutions per minute
SEB - State Electricity Board
SO_2 - Sulphur Dioxide
sq.cm. - Square Centimeter
STKWSSK - Shri Tatyasaheb Kore Warana SSK Ltd.
T&D - Transmission and Distribution losses
TCD - Tons (sugar cane) Crushed per Day
TCH - Tons Crushed (sugar cane) per Hour
TDS - Total Dissolved Solids

List of abbreviations

TERI	-	Tata Energy Research Institute
TG	-	Turbo Generator
TPH	-	Tons per Hour
TS	-	Total Solids
UNDP	-	United Nations Development Program
UPS	-	Uninterrupted Power Supply system

Project Summary

Project Name:	GEF Implementing Agency
Sustainable bagasse based cogenerated power distribution in the command area of Shri Tatyasaheb Kore Warana Sahakari Sakhar Karkhana Ltd. In Taluka Panhala, district Kolhapur, Maharashtra	United Nations Developmetn Programme
Country in which the project is being implemented: India	Country eligibility
GEF Focal Area:	Operational Programme: OP 12
	The GEF Operational Program on Integrated Ecosystem Management (OP#12) provides a comprehensive framework to manage natural systems across sectors, and political or administrative boundaries within the context of sustainable development. It facilitates inter-sectoral and participatory approaches to natural resource management planning and implementation on an ecosystem scale. OP#12 also facilitates prioritization and strategic sequencing of needed policy reforms, investments, and other interventions. The Operational Program is not aimed at addressing natural resource management issues related to a single GEF focal area, but at bringing synergy between three of the GEF focal areas (i.e. Biological Diversity, Climate Change, and International Waters) and land degradation to optimize multiple benefits. It responds to growing stakeholders' interests in addressing holistically multiple convention objectives in

	accordance with national priorities. It builds on and complements GEF's existing Operational Programs by providing opportunities to address issues related to the conservation and sustainable use of biodiversity, land degradation, management of water bodies, and/or stabilization of atmospheric greenhouse gases through a programmatic approach and within the context of sustainable development. Optimum utilisation of available resources of bagasse and steam at STKWSSK's sugar mill to generate maximum power, combined with measures to maximize energy economy in the sugar plant to have maximum surplus power for distribution. Taking over the power distribution for MSEB in STKWSSK's Command Area, taking efficiency measures to reduce the peak demand.

Project summary

Project Identifiers	
1. Project Name: Sustainable bagasse based cogenerated power distribution in the command area of Shri Tatyasaheb Kore Warana Sahakari Sakhar Karkhana Ltd. in Taluka Panhala, district Kolhapur, Maharashtra	**2. GEF Implementing Agency:** United Nations Development Programme
3. Country in which the project is being implemented: INDIA	**4. Country Eligibility**
5. GEF Focal Area: Climate Change	**6. Operational Programme:** Optimum utilisation of available resources of bagasse and steam at STKWSSK's sugar mill to generate maximum power, combined with measures to maximize energy economy in the sugar plant to have maximum surplus power for distribution. Taking over the power distribution from MSEB in STKWSSK's Command Area, taking efficiency measures to reduce the peak demand.

SALIENT FEATURES OF THE PROJECT

- The Project has two components:
  - *Optimum Utilisation of available resources of bagasse and steam to generate maximum power, combined with measures to maximize energy economy in the sugar plant to have maximum surplus power*
  - *To distribute power in STKWSSK's Command Area, taking efficiency measures to reduce the peak demand in the Area.*
- ***In the first component, the Project will generate 28.3 MW (season) and 17.5 MW (off-season). Through modernisation and resource recycling measures, it will reduce the captive consumption to 11.5 MW (season) and 2.5MW (off-season), providing surplus power 16.8 MW (season) and 15 MW (off-season).***
- ***In the second component, the Project will adopt measures to reduce the agricultural demand by 33%(21.2 MU) TO 69.9 MU through conservation of irrigation water and the domestic and non-domestic demand by 11%(8.1 MU) to 65.2 MU through use of solar PV based renewable energy systems for home and street lighting.***
- ***The Project will use for the first time in the country prepaid energy meters for agricultural consumers to control the power usage and improve the revenue collection.***
- *Current electrical demand in STKWSSK's command area*

Agricultural consumers:	***19114***	***Demand: 91.1 MU***
Domestic consumers:	***33958***	***Demand: 67.8 MU***
Non-Domestic consumers:	***17414***	***Demand: 5.5 MU***
Total current demand:		***164.4 MU***

- ***The total demand after the efficiency measures will be 135.1 MU.(18% reduction)***
- The Project proposes to take over the power distribution in its command area from MESB, where:
  - *It proposes to supply power to:*
    - *All agricultural consumers: demand after*
    - *efficiency measures are implemented:* 69.9 MU
    - *All Non-Domestic consumers: demand after*
    - *Efficiency measures* 4.4 MU
    - *Domestic supply to STKWSSK's members(20000): demand after efficiency measures:* 27.9 MU
    - *Total* 102.2 MU

- *Distribute MSEB power (32.9 MU) to other domestic consumers(13958) in the command area.*

➢ *The Project will enable MSEB to stop its loss making supply to agricultural consumers and continue only the viable supply to domestic consumers in the command area.*

➢ Action learning project (ALP)

The reform measures will be taken up through the approach of ALP to ensure effective and smooth adoption of the reforms.

➢ Environmental benefits

- *The Project will result into CO_2 emission abatement of 29338 MT/Year, saving Rs. 126.74 million in mitigation every year.*
- *Reduce sugar factory effluent from 4000 Cum/day to 960 Cum/day.*
- *Fully utilize distillery effluent of spent wash in composting.*
- *Increase the utilization of sugar mill press mud in composting from 16000 MT/year to 26000 MT/year and improve the compost value of balance for use of farmer members.*

➢ Project costs: (Rs. Million)

• *Cogen Plant and sugar mill efficiency measures:*	1063.90
• *Incremental Costs for reforms and institutional mechanism:*	*586.20*
• *Total:*	*1650.10*

➢ Proposed Financing (Rs. Million)

• *Cogen Plant and Sugar Mill efficiency measures :*		
• *STKWSSK:*	*106.39*	
• *Government of Maharashtra*:*	*957.51*	
• *Total:*		*1063.90*
• *Incremental Costs: International Agencies:*		*586.20*
• *Total:*		*1650.10*

7. Project linkage to national priorities, action plans and programmes:

- India is going through a continuing power crisis, the current shortage at 15% and peaking shortage at 30%.
- The state owned power utilities are unable to cope up with this situation, being themselves besot with inherent problems like huge T & D losses, unremunerative tariffs, poor recovery, etc pushing them into severe financial crisis. The state governments also, on account of their own deteriorating financial health, find it increasingly difficult to financially prop up the utilities.
- In this scenario, bagasse based power cogeneration by the sugar factories offers an alternative worth serious consideration for decentralized distribution in the rural areas, as it aims for a fuller utilization of a clean and renewable energy source like bagasse, already available with the sugar factories. This option would also be beneficial to the environment, as it would lead to a reduction in the GHG emission from use of fossil fuels for power generation, that it would replace.

8. GEF national operational focal point and date of country endorsement:

Project Objectives and Activities

9. Project Rationale:

- MSEB also is suffering a similar fate as other utilities.
- The sugar factories with their infrastructure, experience of power generation for captive needs, availability of potential resources like bagasse, steam, water and a position of influence in their area of command are in an ideally suited position to take over the power distribution form MSEB in their area through the cogenerated power.
- This will offer advantages for the rural consumers like better and assured supply, reduced T & D losses, better customer service, etc.
- The proposed Project to be implemented by STKWSSK at Warananagar would serve as the demonstration project to try and test this concept.

10. Project Objectives:	Indicators
• Set up a power cogeneration project to optimize the utilization of available resources of bagasse, steam and water. • Integration with conservation of in-house power and water and recycling of waste water for maximising surplus power for distribution. • Take over the power distribution function from MSEB in the command area. • Develop institutional mechanism for power distribution through active involvement of power consumer bodies for efficient and effective retailing, economical utilization, monitoring and revenue recovery. • Bring in discipline in use of energy. • Motivate and train farmers to conserve irrigation water and pumping power. • Conserve power consumption in the area by supporting consumers to adopt alternative renewable energy based systems. • Build capacity for planning and execution of similar projects and generate adequate experience and database for replicating the model in other candidate factories.	• Power generation, MW • Captive power consumption, MW • Fresh water requirement, cum/day • Effluent generation, cum/day • Annual power requirement distributed in the area, MU • Consumer societies handling retail distribution and O&M • Irrigation water consumption, cum/Mt cane • Number of prepaid energy meters installed • Number of solar lighting units installed

11. **Project Outcomes:**	**Indicators**
▪ Year round bagasse based generation of power of 28.3 MW during cane crushing season and 17.5 MW during the balance period. ▪ Improved energy and water economy of the plant making available maximum power for distribution, 102.2 MU during the year. ▪ Supplying the power requirement (135.1 MU) of the area of command through own supply and balance on behalf of MSEB. ▪ Releasing the state government from its obligation of paying subsidy to MSEB every year for power supply at unremunerative rates in the area of command. ▪ Conservation of one third (106 Mn cum) irrigation water through helping cane farmers adopt efficient agricultural practices, leading to annual power saving of 21.2 MU. ▪ Saving of conventional power (8.1 MU/year) by supporting consumers to adopt solar based lighting for home and street lighting. ▪ Committed involvement of consumers through participation in retail level distribution, O & M and recovery. ▪ Generation of self employment for over 200 local youth through training for retail O & M. ▪ Usage of prepaid energy meters for the first time in the country for agricultural consumers for inculcating disciplined and conscientious use of energy. ▪ Serving as a demonstration focus for replication of the concept on a wider level in suitable sugar factories.	▪ Category and number of consumers to whom power distributed ▪ Consistency of supply voltage. ▪ Continuity in terms of number of hours of continuous supply per year. ▪ T & D losses (%) ▪ Saving of power subsidy from State Government in the area, Rs. Million per year ▪ Irrigation water -consumption, cum/MT cane ▪ Agricultural power consumption, MU ▪ Domestic and non-domestic consumption, MU ▪ Number of local sustained jobs ▪ Revenue recovery, in receivables ▪ Number of replication projects in other sugar factories

12. Project Activities to achieve outcomes:

- Preparation of DPR, detailed engineering and execution of work for erection and commissioning of cogen plant and efficiency measures in the mill complex
- Procurement of requisite licenses and permissions and compliance of formalities pertaining to power generation and distribution.
- Implementation of efficiency measures to reduce the peak demand in the area: installation of solar lighting systems for the co-operative members.
- Motivation and training of farmers to adopt measures to conserve irrigation water and reduce pumping power.
- Installation of prepaid energy meters for agricultural consumers.
- Setting up of institutional and organisational mechanism for distribution of power in the command area.
- Building up of the experience and expertise for power generation and distribution through Action Learning Project.

Indicators:

- DPR
- Commissioning of cogen plant and plant efficiency measures
- Commissioning of solar lighting systems
- Quarterly progress reports of project implementation to funding agencies
- Commencement of power distribution
- Proceedings of brainstorming workshops
- Training manuals
- Periodic independent evaluation of quantified project benefits during operation

13. **Estimated budget (Rs. Million)**

Cogen Plant and Plant Efficiency Measures		***Incremental Costs***	
STKWSSK	**: 106.39**	**GEF/Other International Agencies**	**: 586.20**
Government of Maharashtra*	**: 957.51**	**Total**	**: 586.20**
Total	**: 1063.90**		

TOTAL PROJECT COST: 1650.10

- Contribution as one time grant equal to less than 5 years of power subsidy to MSEB for agricultural supply in the command area.

Information on institution submitting project brief

14. Information on project proposer and implementer:

Shri Tatyasaheb Kore Warana Sahakari Sakhar Karkhana (STKWSSK) was one of the first cane grower cooperative sugar factories in Maharashtra. Starting from a 1000 TCD plant, the mill today has a crushing capacity of 7100 TCD, among the highest in the country.

Under its visionary leadership, the co-operative has developed a remarkable industrial complex around the sugar factory consisting of: a distillery, paper plant, compost plant, dairy, export oriented fruit processing plant, etc.

In addition, the society has promoted a institutional network of educational, training, and commercial organizations in the area, making a deep impact on the lives of the residents in improving the quality of life.

STKWSSK's technical staff is well experienced in the power generation and usage for captive requirements.

The network of irrigation societies promoted by STKWSSK at village level in the command area will form the base for effective functioning of the proposed project.

15. Date of inintial submission of project concept:

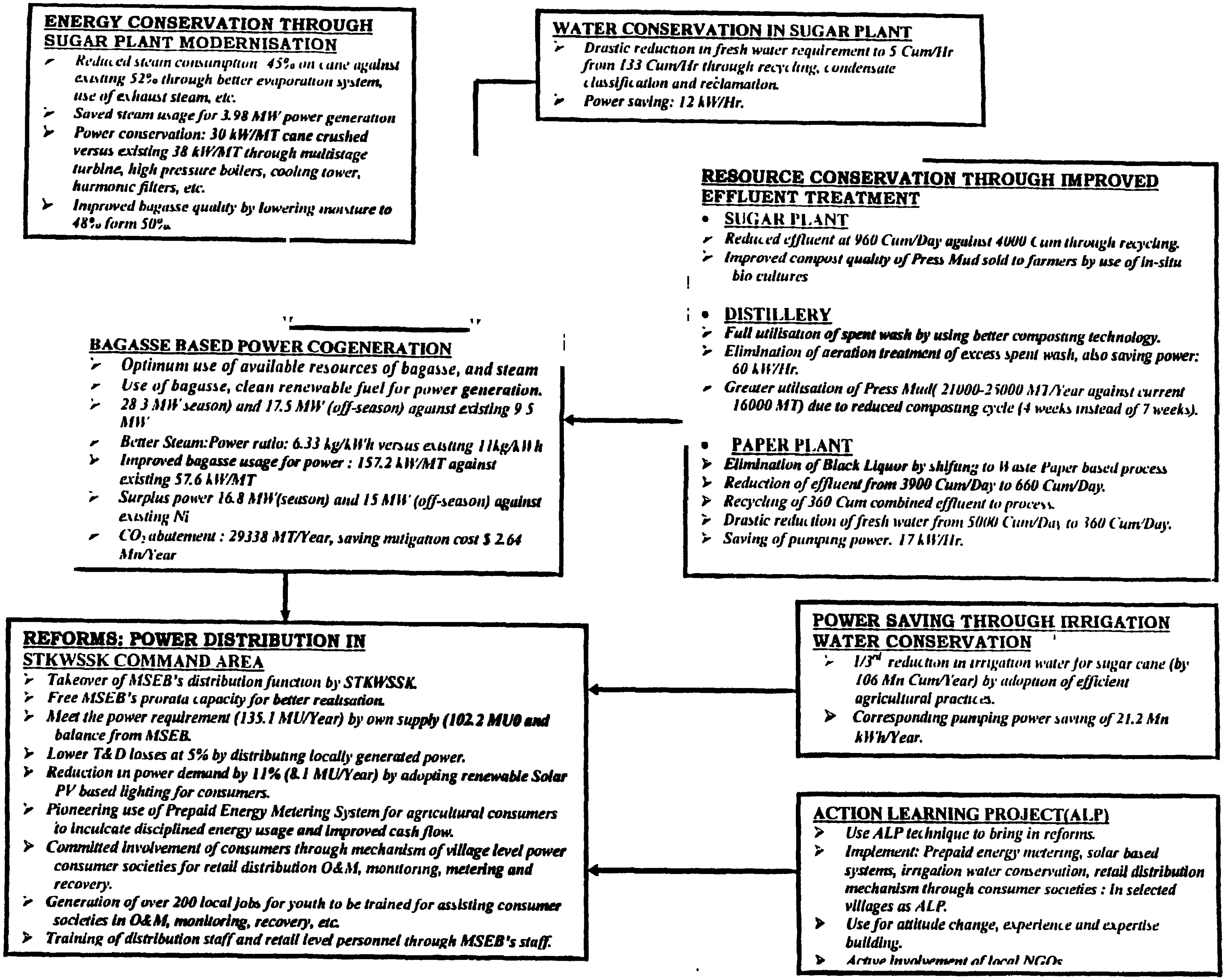
Information provided by implementing agency:

16. Project identification number:

17. Implementing agency contact person:

Mr. V S.Chavan
Managing Director,
Shri Tatyasaheb Kore SSK ltd.
Warananagar, Taluka Panhala,
District Kolhapur 41
02328 24081/87
Fax: 02328 24090
E-mail: vs_chavan@yahoo.com

18. Project linkage to implementing agency programme (s):



ENERGY CONSERVATION THROUGH SUGAR PLANT MODERNISATION

- *Reduced steam consumption 45% on cane against existing 52% through better evaporation system, use of exhaust steam, etc.*
- *Saved steam usage for 3.98 MW power generation*
- *Power conservation: 30 kW/MT cane crushed versus existing 38 kW/MT through multistage turbine, high pressure boilers, cooling tower, harmonic filters, etc.*
- *Improved bagasse quality by lowering moisture to 48% form 50%*

WATER CONSERVATION IN SUGAR PLANT

- *Drastic reduction in fresh water requirement to 5 Cum/Hr from 133 Cum/Hr through recycling, condensate classification and reclamation.*
- *Power saving: 12 kW/Hr.*

RESOURCE CONSERVATION THROUGH IMPROVED EFFLUENT TREATMENT

- SUGAR PLANT
- *Reduced effluent at 960 Cum/Day against 4000 Cum through recycling.*
- *Improved compost quality of Press Mud sold to farmers by use of in-situ bio cultures*

- DISTILLERY
- *Full utilisation of spent wash by using better composting technology.*
- *Elimination of aeration treatment of excess spent wash, also saving power: 60 kW/Hr.*
- *Greater utilisation of Press Mud(21000-25000 MT/Year against current 16000 MT) due to reduced composting cycle (4 weeks instead of 7 weeks).*

- PAPER PLANT
- *Elimination of Black Liquor by shifting to Waste Paper based process*
- *Reduction of effluent from 3900 Cum/Day to 660 Cum/Day.*
- *Recycling of 360 Cum combined effluent to process.*
- *Drastic reduction of fresh water from 5000 Cum/Day to 360 Cum/Day.*
- *Saving of pumping power. 17 kW/Hr.*

BAGASSE BASED POWER COGENERATION

- *Optimum use of available resources of bagasse, and steam*
- *Use of bagasse, clean renewable fuel for power generation.*
- *28 3 MW season) and 17.5 MW (off-season) against existing 9 5 MW*
- *Better Steam:Power ratio: 6.33 kg/kWh versus existing 11kg/kWh*
- *Improved bagasse usage for power : 157.2 kW/MT against existing 57.6 kW/MT*
- *Surplus power 16.8 MW(season) and 15 MW (off-season) against existing Ni*
- *CO_2 abatement : 29338 MT/Year, saving mitigation cost $ 2.64 Mn/Year*

REFORMS: POWER DISTRIBUTION IN STKWSSK COMMAND AREA

- *Takeover of MSEB's distribution function by STKWSSK.*
- *Free MSEB's prorata capacity for better realisation.*
- *Meet the power requirement (135.1 MU/Year) by own supply (102.2 MU0 and balance from MSEB.*
- *Lower T&D losses at 5% by distributing locally generated power.*
- *Reduction in power demand by 11% (8.1 MU/Year) by adopting renewable Solar PV based lighting for consumers.*
- *Pioneering use of Prepaid Energy Metering System for agricultural consumers to inculcate disciplined energy usage and improved cash flow.*
- *Committed involvement of consumers through mechanism of village level power consumer societies for retail distribution O&M, monitoring, metering and recovery.*
- *Generation of over 200 local jobs for youth to be trained for assisting consumer societies in O&M, monitoring, recovery, etc.*
- *Training of distribution staff and retail level personnel through MSEB's staff.*

POWER SAVING THROUGH IRRIGATION WATER CONSERVATION

- *1/3rd reduction in irrigation water for sugar cane (by 106 Mn Cum/Year) by adoption of efficient agricultural practices.*
- *Corresponding pumping power saving of 21.2 Mn kWh/Year.*

ACTION LEARNING PROJECT(ALP)

- *Use ALP technique to bring in reforms.*
- *Implement: Prepaid energy metering, solar based systems, irrigation water conservation, retail distribution mechanism through consumer societies : In selected villages as ALP.*
- *Use for attitude change, experience and expertise building.*
- *Active Involvement of local NGOs*

1

Project context

Introduction

A case is made for taking over the power distribution in the rural command area of a sugar factory based on optimum utilisation of available resources of bagasse and steam, on the basis of a consideration of the threats faced and the benefits such a project would derive for the power sector. The objectives of the Project proposed by STKWSSK are described along with the expected outcomes and activities required to achieve the outcomes. The sustainability of the project on various grounds is analysed. The replicability of the project and its replication potential is discussed, giving the list of sugar factories in Maharashtra which could take up similar projects.

Background

India needs increasing power for its economic development and growth. However, while production of electricity has grown manifold, its consumption is rising at a faster rate. As of now, the power shortage is estimated at 15% and the peaking shortage at 30%. The state utilities are unable to cope up with the increasing power needs and have to resort to continuous load shedding. Inefficient power distribution systems, coupled with the lack of control on users leading to huge pilferage and wastage of electricity, have resulted in burgeoning T & D losses as high as 50%.

On the other hand, the unremunerative low tariffs for supply of power to the agricultural sector, the largely unmetered supply to this segment and low recovery levels have seriously jeopardized the financial health of the power utilities. To subsidise the losses thus incurred by the utilities for supply to the agricultural consumers, is proving to be a very heavy burden on the state exchequers. International financial institutions like the World Bank are demanding the phasing out of such subsidies as stipulation for their financial support to the governments.

Another important aspect is, that over 50% of the power generation in the country uses fossil fuels, mostly coal, whose sources are limited. The use of this fuel causes GHG emission posing a threat to the environment. A logical alternative to effectively meet the aforesaid issues is to tap other cleaner sources for power generation.

In this context, cogeneration encompassing simultaneous production of power and useful thermal energy (steam) from a single fuel source, offers an attractive solution to meet the industrial energy requirements in an efficient manner.

The sugar factories, producing bagasse as a process waste and requiring steam for the process, provide an attractive cogeneration option. Bagasse is a clean and renewable source of energy and the sugar factories are already using it to generate captive power. In case of big sugar plants, a substantial quantity of bagasse remains as a surplus, even after meeting captive power requirements. Therefore, it is logical for such units to generate surplus power for export by optimum utilization of bagasse and the process steam. The use of bagasse based cogeneration for decentralized distribution of electricity in the predominantly rural areas of the sugar factories, is a concept that merits serious consideration.

Project rationale

MSEB in Maharashtra is also plagued by similar problems of high T&D losses, unremunerative tariffs for agricultural sector detrimentally affecting its financial health. In this scenario, the sugar co-operatives can play a significant role by fully utilising their resources of bagasse, the clean fuel and process steam to generate power and distribute it in their predominantly rural command areas.

MSEB's problems

MSEB, the state owned power utility in Maharashtra, shows the same state of affairs as the national power scenario. Currently, against the online capacity of 10780 MW, MSEB has to operate a load shedding of 1355 MW for morning peak and 1138 MW for the evening peak. MSEB website This frequent load shedding and restriction of power supply to the various category of consumers calls for an urgent need for augmenting the power generation.

Factors like the continuously increasing and uncontrollable T & D losses (currently about 40%), continued supply to the agricultural sector at flat tariffs much below its average cost of supply (about Rs. 2.90 per kWh), low recovery and increasing receivables, etc. are fast pushing MSEB to a level of bankruptcy. MSEB finds it increasingly uneconomical to supply power to the rural areas.

Potential role of sugar co-operatives

The sugar factories generate bagasse as a waste to the extent of about 30% of the cane crushed by them. With the present practice of captive power generation, they are able to utilize only about 75 to 80% of this quantity. The unutilised bagasse creates storage and disposal problems for the factory. The factory can get little returns from the excess bagasse

Moreover, the sugar factories have the necessary infrastructure and other resources like manpower, water, etc. which can be put to a more productive use. These resources can be best utilized to extend the power generation by the sugar factories for distribution in their area. The sugar factories are located in predominantly rural areas with a majority of agricultural consumers. As most of them are members of the sugar cooperatives, the factories are in the best position to supply power to these farmers as well as recover the revenue.

Similarly, they can take a positive step of conservation of the valuable natural resource of water used unsparingly for irrigation in their area.

As the power generation by the sugar factories would be based on the renewable clean fuel of bagasse, it is eminently compatible with both the national as well as global priorities of mitigating the GHG emissions, by partly obviating the need for coal based power generation. Unlike coal, the sugarcane crop which is the source of the bagasse fuel, has the capacity to not only fully absorb the CO_2 generated, but also to release proportionate quantity of O_2 to the environment, thereby positively improving its quality.

Distribution of such power in the vicinity of the generation point, would reduce the T & D losses, improving the viability and quality of supply. Such projects can reduce the load on the generating and distribution capacity of the state utility like MSEB to some extent, allowing it to cater to the needs of other areas where it can get a better return. This proposition will be in line with the reforms under active consideration for the power sector. These considerations make a very strong case for supporting bagasse based power generation at a sugar factory and distribution to its area of command. Such a project can serve as a demonstration and model for replication in other suitable sugar factories.

Present project

In line with the priorities indicated above, the Tatyasaheb Kore Warana Sahakari Sakhar Karkhana Limited (STKWSSK) at Warananagar, Kolhapur district in Maharashtra, a reputed and progressive sugar factory with an excellent track record of adopting innovative technologies, proposes to set up a demonstration project for distributing power, based on bagasse based cogeneration at its sugar plant, in the predominantly rural area of its operation. Some of the important factors favouring STKWSSK for setting up such a demonstration project have been discussed below.

- STKWSSK, as one of the largest sugar factories in the state, has a large area of operation extending to over 63 villages.
- The power requirements of this area are substantial, a significant part of which come from agricultural consumers, most of whom are the members of STKWSSK. STKWSSK, on account of its sugar plant size, possesses a potential for a substantial power cogeneration capacity.
- The various industries promoted by STKWSSK, themselves would be major consumers of the electricity generated.
- The industrial base set up by STKWSSK would serve as the focal point for development and growth of further industrial and commercial activity in the area.

Project objectives

The project broadly incorporates two sets of objectives based on the immediate power and efficiency requirements and on the long term measures for a sustainable power generation and distribution system. The specific short-term objectives for the project are as follows;

- To conserve and optimally utilize the available resources of bagasse, steam and water for maximising the power generation.
- To adopt suitable modifications and techniques in the sugar plant to achieve economy in the captive energy consumption.
- To institute measures in the sugar complex to conserve and recirculate maximum quantity of water and also to achieve saving of pumping power.
- To adopt techniques in the sugar complex to minimise the effluent and wastewater generation, to reduce the fresh water requirement to the maximum possible by treating and recycling the wastewater/effluent. This would also achieve saving in power for handling and treatment of effluent and fresh water.

- To maximize the distributable power by such above measures. To supply and distribute the surplus power in the area of command.
- To build suitable institutional mechanism for power generation, distribution, operation, maintenance and revenue collection in the area of command through committed involvement of the consumer-stakeholders in the project.
- To make arrangements with MSEB for distribution of additional requirement of power for meeting gap, if any, in the power requirements of the area and the project's capacity to supply.
- To introduce and operate systems to minimize the T & D losses and provide quality power supply to the consumers.

The long term measures focusing on putting into place, the institutional arrangements and conservation and efficiency aspects are as follows;

- To motivate and train the consumer farmers in the area of command to adopt appropriate agricultural practices in order to conserve the irrigation water resulting in power saving, soil conservation and improved productivity.
- . To bring in discipline and control in the use of power for irrigation water.
- To reduce the peak power load in the area by motivating and supporting the consumers to adopt alternative renewable electricity sources/implements.
- To build capability for planning, execution and successful operation of similar projects.
- To serve as a demonstration platform for implementing the core concepts.
- To remove barriers for decentralized generation and distribution of power based on a renewable source of bagasse for rural power needs by developing proper institutional linkages, optimum utilization of available bagasse and proper sizing of the power plant.

Baseline scenario (business as usual)

The unreasonable and unsustainable tariffs at which MSEB has to supply power to the majority of the consumers, are making the utility financially weak.

During 1999-00, MSEB's average cost of supply of was Rs.2.12 per kWh, against the average realization of Rs. 1.71 per kWh, leaving a gap of Re.0.41, i.e. 24%. The uncontrollable and burgeoning T & D losses, along with poor revenue recovery performance, are worsening the situation. The inability of MSEB to cope up with the energy demand has resulted in the poor quality and inadequate supply, as evident in the continued load shedding it is resorting to.

The difference in the cost of supply and the revenue collection, specially from the agricultural consumers, is claimed by MSEB from the state government. During 1999-00, this amounted to Rs.20840 million. However, the state government's lack of financial resources to bail out MSEB will push the utility further in the void.

Threats

MSEB will face increasing inability to meet the power demand effectively, specially from the rural area. Moreover, the gap between the power demand and supply will further broaden, adversely affecting the economic growth. In addition to this, the poor quality and continuity of the supply to the rural area is detrimentally affecting the crop production and economics. In Kolhapur district, in which the command area of STKWSSK is situated, the load shedding for rural area has been 90 MW for over 8 hours a day since August 2001. The situation will worsen still. On the other hand ,the T & D losses of MSEB will be difficult to check by current practices and will further increase.

MSEB incurs an estimated yearly loss of about Rs. 220 million for supply to agricultural consumers in STKWSSK's area of command. This will further increase as the utility's cost of supply increases. At the state level, this amounts to a subsidy of Rs. 20840 million (year 2000) . It is no longer possible to sustain this burden on account of the worsening financial status of the exchequer. The current subsidy levels, if continued, will push MSEB to bankruptcy and the impending bankruptcy of the utility will lead to collapse of the power supply system in the state.

On the other hand, the agricultural sector will violently oppose any proposals to increase/rationalize their tariff. Essentially, the power tariff for agriculture should be directly linked to the crop economics. However, it is doubtful whether such a move would be taken and accepted in the near future.

The sugar factories will also continue to use the bagasse and other resources like water inefficiently and generate power for only captive requirements. A significant part of these resources will, therefore, go waste. The unchecked excessive use of irrigation water, specially by the sugarcane farmers, will continue in the light of the very low tariff and unmetered supply This, apart from wastage of valuable water, will increase the soil salinity, decreasing its fertility and eventually the crop productivity

Moreover, the adverse impact on the environment from GHG due to the continued dependence on fossil fuels for thermal generation will continue and aggravate

Alternate scenario - with the proposed project

STKWSSK will use the latest technology for setting up the most modern bagasse cogeneration power plant with a net generation capacity of 28.3 MW during season and 17.5 MW during off season. (refer Chapter 2: Cogen plant sizing)

By rationalizing and modernizing the sugar plant, the captive power requirement will be optimised. Of the 28.3 MW generated during the season, the captive power will be 11.5 MW, leaving 16.8 MW for distribution to the villages. During off season, of the 17.5 MW generated, the captive power will be 2.5 MW, leaving 15 MW for distribution to the villages (refer Chapter 2: Maximising the saleable power). It may be mentioned that, STKWSSK will completely take over the power distribution function of MSEB in its area of command extending to 63 villages.

The total annual electricity requirement for the area of command is estimated at 164.4 MU. The current unchecked consumption and wastage of the very critical resource of water for irrigation will be brought down by 33% by motivating and training the farmers to adopt efficient agricultural practices. (refer Chapter 2: Proposal for irrigation water and power economy). This will also save the pumping power substantially by 21.2 MU per year, helping to bring down the peak demand This approach will also help in mitigating the high salinity of the soil due to excessive irrigation. The demand will be further brought down by 8.1 MU by installing renewable solar PV based home lighting units at the houses of the co-operative's members and street lighting in the villages. (refer Chapter 2: Use of solar lighting). Hence effective total annual requirement for the command area will be brought down to 135.1 MU.

It is important to note that the cogenerated power will cover the total agricultural load, the total non-domestic load and domestic load of the members of the STKWSSK in the area of command. The total generated power will be evacuated at the MSEB 33 kV sub-station. The remaining small fraction of the domestic load will be covered by MSEB supply, a viable proposition for MSEB. Hence, the co-generated power will completely take care of the loss making agriculture load. The project will release MSEB from supplying 102.2 MU, most of it at loss making tariff to the agricultural sector in the area, allowing it to cater to the high tariff consumers elsewhere. The state government will also be relieved from the payment of annual subsidy of about Rs. 220 million to MSEB for its supply to agricultural consumers in the command area, after the project commences operation. The consumers will get an assured and quality power supply.

The Project will also bring in discipline and control in the usage of power and water for irrigation by using for the first time in the country, a prepaid energy metering system for the agricultural consumers. (refer Chapter 2. Demand control: Use of prepaid energy meters)

The Project will use strategies to maximize the conservation and recycling of captive resources like water, process steam, bagasse; as well as treat, minimize and recycle the effluents generated in the sugar complex to achieve resource economy, including water saving.(refer Chapter 2: Energy efficiency improvements in the sugar plant, Energy conservation through water recycling and Conservation through waste and effluent treatment and recycling)

The consumers, being the major stakeholders, will be motivated to have a committed involvement in the operation of the project by making them a part of the institutional mechanism for retail level distribution, operation, maintenance and recovery. (refer Chapter 2: Institutional set-up for retail level distribution)

For a smooth implementation of the above described reforms, the project proposes to use the approach of Action Learning Project (ALP). Initially the measures will be taken up in the selected villages during the project execution phase itself, in order to bring about attitudinal changes among the consumers and gain valuable experience for replicating the reforms over the entire command area.

Utilisation of the clean renewable fuel of bagasse for the generation of this distributable power, will eventually aid in abatement of GHG through mitigation of 29338 MT of CO_2 every year. Over a 25 year assumed productive life of the project, this will amount to an abatement level of 733450 MT. Considering the equivalent cost of mitigation of CO_2 at about US $ 90 per T, this translates into a saving of US $ 66 million over the economic life of the project. Besides, the project will also abate significant quantities of SO_2 and NO_x generation by substituting coal.

This project, by demonstrating a suitable mechanism to overcome the current technological, financial, management and institutional barriers perceived in opting for co-generated power distribution in the rural area, will enhance the replication potential of the project, making it possible to adopt the strategy on a wider scale to significantly solve the rural power requirements as well as to improve the agricultural productivity through irrigation water conservation. The adoption of the project strategy on such wide level will also help improve the financial viability of MSEB by taking off its hands, a major rural region, where its supply is highly uneconomical.

Case for GEF involvement

Table 1. Total environmental benefits of the project

Benefit	Project	Gross Potential (with replication)
CO_2 abatement	29338 MT/year	About 1 million MT/year
Effluent reduction	Sugar mill: By 75%, Distillery: full utilisation of spent wash	Comparable results for each project
Value addition to waste	Sugar mill: enhanced compost value of press mud Distillery: higher compost production	Comparable results for each project

GEF is committed by its constitutional mandate to preserving and improving the global environment. The proposed project will positively impact the environment by mitigating the GHG emission and also reduce the effluent load, as presented in the above table, thus qualifying for its contribution under the Climate Change focus of GEF.

The reforms aspects mooted by the project of taking over the distribution function of MSEB in STKWSSK's area of operation, primarily to the agricultural sector, using renewable sources like the solar systems for lighting and bringing about conservation of the irrigation water through adoption of efficient techniques to reduce the peak demand, need an outright financial support for the associated incremental costs in order to ensure the financial viability and sustainability of the project.

GEF's involvement on this front will go a long way not only for providing this support but lending an institutional back up and credibility to the project, which STKWSSK can effectively use for mustering financial grant for its project.

For GEF also, this would mean supporting a path breaking innovative project, which can pave the way for adoption of similar approach on a wider level and have a far reaching impact on supply of power to the rural sector, besides the obvious benefit to the environment on a much significant level.

In India there are over 30 sugar co-operatives having a potential to replicate and derive all the benefits of such a project.

GEF responsibility

It is proposed that GEF provide an outright grant to the extent of Rs 586.2 Million towards the incremental cost of the project, which will cover the cost of preparing the Detailed Project Brief, DPR and Detailed Engineering services (EPS) for the project, training and reforms. This will support the project in the initial phase and help give an impetus to the project take off.

The funding for the cogen plant and sugar mill efficiency measures will come from STKWSSK's own resources and out right grant from Government of Maharashtra equivalent to the subsidy it would have to pay to MSEB for agricultural sector supply at low tariff in the command area for next 5 years.

Project sustainability analysis

Barriers to the sustainability of the project on the technical, institutional, financial and social grounds are identified and measures to overcome them are discussed.

Technical sustainability

The Co-generation technology requires utilization of high pressure boilers The major barrier perceived in this case is the availability of the state of art equipment within the project time frame and also the expertise necessary to operate the system. The first barrier can be overcome through proper planning of the project execution Possibility of imports could also be explored.

The expertise for operation and maintenance will be acquired by selection of core team during the project execution itself, besides organising appropriate training of the plant personnel.

Another barrier can be the irregularities in availability of bagasse, the major input, on account of climatic fluctuations and drought conditions, affecting the cane production. Fortunately, the factory is located in an area where there has been no acute water shortage in the past and water table level is quite high. (around 60 feet). By initiating the water conservation measures, the factory will ensure that the water table will not be affected. Moreover, the factory will initiate long term measures to improve the average cane yield to ensure adequate supply of cane. Bagasse shortage, if any, can be met from the nearby sugar factories.

Next, the availability of trained and experienced manpower for operation and maintenance of the distribution network can be a major influencing factor. This barrier will be overcome by utilizing services of existing MSEB staff in the initial transition period. During this period, the staff recruited by the factory will be appropriately and adequately trained and gain experience to take over the distribution independently after the arrangements with MSEB are terminated.

The local ITI level youth, to be selected for supervising the retail level O & M as well as monitoring and recovery on behalf of the consumer societies, will be given a proper training through the MSEB and project staff.

This will also include the O & M for the solar systems and the prepaid energy metering system.

Financial sustainability

The past experience with co-generation projects indicates that the high cost of financing has been responsible for higher cost of generation compared with the price accepted through PPAs. This has affected the viability of such projects.

In the present case, since the project envisages distribution of power in its command area, where there are predominantly agricultural consumers, the very low tariff to this sector can further jeopardize the financial viability.

The project proposes to overcome this barrier by an innovative financing approach as follows;

The Government of Maharashtra is subsidising MSEB to the extent of over Rs. 220 million every year for supply at loss making flat tariff to the agricultural consumers in the command area. This however, cannot continue on account of the conditions put by the World Bank, as well as the financial health of the government itself, to phase out this subsidy in the near future. The project proposes to approach the state government to provide a grant as a one time payment equivalent to less than 5 years' subsidy to finance the cost of the cogen plant including the efficiency enhancement modifications in the sugar mill.

The proposal for approaching GEF or other international agencies to finance the incremental cost of the project components of the reforms aspects and the institutional mechanism will also support the financial sustainability.

This funding approach will remove the financial burden on the project of recovering the capital investment.

The trend for rationalization of the tariff regime regulated by the ERCs indicates that there will be an improvement in the agricultural tariff also in future, linking it up to the cost of the supply. This possibility can further improve the financial sustainability.

A serious threat to the project during its operation can be from the inadequate revenue collection. The existing recovery record of MSEB for supply to the agricultural sector is very poor The factory on the other hand, will be in an advantageous position in this respect. Most of the agricultural consumers in the area of proposed distribution are, either members of the society or supply cane to the factory. The factory can ensure collection of electricity bills from the cane account of these farmers Moreover, the prepaid energy metering system for these consumers will ensure that the energy consumed is paid for in advance. This will also help improve the liquidity.

As an innovative approach, it is proposed to distribute the power to the villages through a mechanism of village based co-operative societies. The existing frame work of irrigation societies can also be used for this purpose This will help improve the collection.

Institutional sustainability

The institutional sustainability of the project will be achieved by building proper organizational structure as well as institutional linkages. The project will comply with all the essential statutory and regulatory obligations and will operate in that environment.

The in-house organization will be built up around a core team of qualified and experienced technocrats. The organizational capabilities will be built up through providing proper training including that from the MSEB through proper arrangements for generation and distribution including O & M.

For the small consumer level distribution, it is proposed to use the mechanism of village level societies to be formed by the consumers themselves. The metering and billing from STKWSSK will be to these societies, who will further distribute the load to their members, taking up the responsibility of monitoring, metering, billing and recovery through the agency of local self employed trained technicians. The statutory and institutional formalities and requirements for these arrangements will be complied with. STKWSSK will organize requisite training to these societies and the technicians. The existing lift irrigation societies will also be co-opted in this mechanism.

Social sustainability

The rural population in the area will benefit from the supply of quality power, which will remove the impediments it had been facing in carrying out sustainable economic activities. The mechanism recommended for retail power distribution will involve the population at all levels as consumers and stakeholders. Furthermore, this will create job opportunities like line staff, maintenance jobs, meter readers, collection staff, etc. even on local level.

The social sustainability on a wider perspective will be brought about by mobilizing and sustaining stakeholder participation (specially at consumer level) on an ongoing basis through techniques like regular feedback, workshops, transparency in the working, etc.

Environmental sustainability

As emphasized earlier, the very basis of the project of bagasse based co-generation will have a positive impact on the environment by mitigating the GHG emission. The project also envisages adequate system for minimizing the effluent generation coupled with the recycling of the treated effluent and wastewater to the mainstream as well as measures to enhance the utility value of factory waste like press mud.

By controlling the irrigation water consumption, the project will check the adverse impact on the soil fertility like the saline soil development brought about by excessive irrigation. Thus the project possesses the core strength to maintain and support environmental sustainability.

Project economic life

Estimated to be minimum 25 years.

Expected outcomes

- Bagasse based generation of 28.3 MW during season and 17.5 MW during off-season.
- Improved energy efficiency of sugar plant, extending the surplus power for distribution to 16.8 MW during season and 15 MW during off-season.
- Better resource conservation and recycling (water, wastewater and effluent) leading to more productive use and power saving.
- Completely taking over MSEB's distribution system in the command area.
- Supplying the demand in the area through own generated power and MSEB power.
- Meeting the entire agricultural and non-domestic load and the domestic load of the co-operative's members from own generation. Supply to remaining domestic consumers through MSEB power.
- Peak demand reduction (8.1 MU) in the area through installation of solar systems for domestic and street lighting.
- Energy saving (21.2 MU) through irrigation water conservation (106 MCM).
- Disciplined and controlled use of power by agricultural consumers and improved cash flow through use of prepaid energy metering system for these consumers.
- Implementation of above stated demand saving and control measures through the approach of Action Learning Project (ALP)

- Committed involvement of consumers through association in retail level distribution, operation, maintenance, monitoring and recovery
- Creation of skilled self employment opportunities for over 200 local youth.
- On going training of project staff, consumer societies and local self employed skilled technicians.
- CO_2 abatement of 29338 MT every year; 733450 MT over the project's estimated economic life, resulting in saving of mitigation cost of US $ 66 million.
- Expertise and experience gained for replication of the project concept.

Replicability and replication potential

The model selected for the demonstration project is built around a large sugar factory of STKWSSK with a large area of operation. Similar conditions prevail at many locations in the country The project will successfully demonstrate overcoming and proper handling of the currently perceived barriers in implementing and operating this type of activity on a sustainable level. This will ensure the replicability of the concept on a wider level.

The preliminary techno-economical, management and institutional assessment of the project emphasizes on the minimum size of the sugar factory to be 3500 TCD with by-products, a large command area for viability and sustainability. There are 25 such factories in Maharashtra alone, who may have the potential to take up similar projects.

Table 2. List of sugar factories in Maharashtra with replication potential:

A)	**Kolhapur District:**	
Sr No	Name of the sugar factory	Installed capacity TCD
1.	Shree Bhogawati S.S.K. Ltd Shahunagar (Parite) Tal karveer	4000
2.	Shree Chhatrapati Shahu S.S.K. Ltd kagal Tal Kagal	3500
3.	Shree Datta S.S.K.Ltd Shirol Post Dattanagar Tal Shirol	5000
4.	Daulat Shetkari S.S.K.Ltd Halkarni Tal Chandgad	3500
5.	Shree Dudhganga Vedganga S.S.K.Ltd Bidri (Maurinagar)Tal Kagal	3500
6.	Jawahar Shetkari S.S.K.Ltd Shri Kallapanna Awadenagar, Hupri-Yelgud,Tal Hatkanangale	5000
7.	Deshbhakta Ratnappanna Kumbhar Panchaganga S.S.K.Ltd Ganganagar Tal Ichalkaranji	5000
B)	**Sangli District**	
8.	Rajarambapu Patil S.S.K.,Rajaramnagar Post-Sakharale,Tal-Walwa	4000
9.	Vasantdada Shetkari S.S.K.Ltd.,Sangli,Tal-Miraj	5000

C)	**Satara District**	
10.	Kisanveer Satara S.S.K. Ltd.,Bhuinj,Tal-Wai	4000
11.	Krishna S.S.K. Ltd,Rethare(Bk),Post-Shivnagar,Tal-Karad	5000
12.	Sahyadri S.S.K.Ltd,Yeshwantnagar,Tal-Karad	7500
D)	**Pune District**	
13.	Bhima S.S.K.Ltd,Madhukarnagar,Patas,Tal-Daund	5000
14.	Shree Chhatrapati S.S.K.Ltd.,Bhavaninagar,Tal-Indapur	3500
15.	Indapur S.S.K.Ltd,Mahatma Phule Nagar(Bijwadi),Tal-Indapur	5000
16.	The Malegaon S.S.K.Ltd.,Malegaon(Bk),Shivnagar,Tal-Baramati	4000
17.	Yeshwant S.S.K. Ltd., Chitamaninagar, Post-Theur,Tal-Haveli	3500
E)	**Solapur District**	
18.	Sahkar Maharshi Shankarrao Mohite Patil S.S.K. Ltd., Shankarnagar-Akluj, Post-Yeshwantnagar, Tal-Malshiras	4500
19.	Shree Vitthal S.S.K. Ltd., Venunagar,Post-Gursale, Tal-Pandharpur	3500
F)	Ahmednagar District	
20.	Shree Dnyaneshwar S.S.K. Ltd., Dnyaneshwarnagar, Tal-Newasa	5000
21.	Padmashree Dr.Vitthalrao Vikhe Patil S.S.K. Ltd., Pravaranagar, Tal-Rahata	4000
22.	The Rahuri S.S.K. Ltd., Shivajinagar,Tal-Rahuri	4250
23.	Sangamner Bhag S.S.K.Ltd., Amrutnagar, Post-Sangamner Sugar Factory, Tal-Sangamner	3500
G)	**Nasik District**	
24.	Niphad S.S.K.Ltd., Pimpalas, Post-Bhausahebnagar, Tal-Niphad	3500
H)	**Osmanabad District**	
25.	Terna Shetkari S.S.K. Ltd., Dhoki(Ternanagar), Tal-Osmanabad	3500

Project components and activities

The project is divided into individual components representing specific work packages. Each component is sub-divided into sub-components and further into individual project activities aimed at achieving the stated outcomes of the project.

Project components

The major components of the project are organised in several sub-components to facilitate a smooth and orderly execution.

Component 1: Setting up of the cogeneration plant

- *Sub-component 1:* Implementing the sugar factory modernization schemes for improvement in the energy efficiency

- *Sub-component 2:* Implementing identified measures to treat/mitigate and recycle the wastewater and effluents in the sugar and by-product plants.
- *Sub-component 3:* Design, procurement and erection of the optimally sized co-generation plant for year round operation with optimized capacity for providing surplus power for distribution.
- *Sub-component 4:* Procurement and installation of solar PV based home and street lighting systems at consumer's end.
- *Sub-component 5:* Initiate measures to conserve irrigation water in the area of operation.

Component 2: Distribution of power in the factory's area of operation

- *Sub-component 1:* Setting up of the institutional and organizational framework for taking over MSEB's distribution function in the area, including policy and licensing compliances.
- *Sub-component 2:* Setting up the power evacuation system, including metering for the co-generated power, to the appropriate grid location of MSEB.
- *Sub-component 3:* Setting up the distribution system in the boundary limit using the existing MSEB network, installing the additional required equipment including metering at the feeder points.
- *Sub-component 4:* Installation of prepaid energy metering system for agricultural consumers.
- *Sub-Component 5:* Generation and sale of electricity.
- *Sub-Component 6:* Set up Billing and Revenue Collection System.
- *Sub-Component 7:* Set up Consumer Servicing System

Component 3: Training and participation of active stake holders

Activities

Component 1: Setting up cogeneration plant

Sub-Component 1: Sugarr factory modernization:

Activity 1: Preliminary study of the plant to freeze the requirement of the modernization.

Activity 2: Detailed study of the sugar plant to identify scope for improvement and specific measures to be taken.

Activity 3. Detailed engineering.
Activity 4: Procure and install the equipment and modifications.
Activity 5: Balance the plant operation with the installed modifications.

Sub-component 2: Mitigation and recycling of wastewater and effluents:
Activity 1: Detailed study of the existing wastewater and effluent generation, treatment and disposal to identify scope for improvement.
Activity 2: Design the measures for improvement.
Activity 3: Procure and install the new equipment for modification.
Activity 4: Balance the plant operation with the installed modifications.

Sub-Component 3: Design, procurement, installation and commissioning of cogeneration plant:
Activity 1: Detailed study.
Activity 2: Detailed design engineering.
Activity 3: Preparation of tenders and ordering procedures.
Activity 4: Erection and start-u.
Activity 5: Manpower recruitment and training.
Activity 6: Commissioning and hook-up with existing system.
Activity 7: Fulfilling statutory requirements.

Sub-Component 4: Procurement and installation of solar systems:
Activity 1: Preparation of tenders and ordering.
Activity 2: Installation and commissioning.
Activity 3. Training users and maintenance personnel

Sub-Component 5: Irrigation water conservation:
Activity 1· Study the existing irrigation practices to identify the excess consumption.
Activity 2: Study and techno-economically evaluate the options for water reduction and select appropriate workable solutions.
Activity 3: Educate the farmers and generate their acceptance, involvement and commitment including incentive system.
Activity 4: Set up a monitoring, control and evaluation mechanism.

Component 2: Distribution of power in the area of operation

Sub-component 1. Setting up institutional and organisational framework
Activity 1: Complete licensing and approval formalities for distribution including tariff approval
Activity 2: Finalise institutional mechanism with MSEB for power transmission and takeover of distribution network
Activity 3: Build up organization for distribution.

Sub-Component 2: Setting up evacuation system:
Activity 1: Design of system including protection system.
Activity 2: Order, procure, erect, commission and hook up.

Sub-Component 3: Takeover of distribution system:
Activity 1: Decide the boundary limits with MSEB.
Activity 2: Decide terms for the takeover.
Activity 3: Install metering and other equipment.
Activity 4: Recruitment and training of staff for O & M

Sub-component 4: Installation of prepaid energy metering system:
Activity 1: Motivation of consumers.
Activity 2: Finalise system requirements
Activity 3: Procure and install.
Activity 4: Educate consumers to use the system.
Activity 5: Train technical personnel for maintenance.

Sub-component 5: Generation and Sale of Electricity:
Activity 1: Design the operating mechanism.
Activity 2. Agreement with MSEB for distributing their power.
Activity 3: Design metering and accounting system.
Activity 4: Install metering at decided locations for monitoring supply and consumption.
Activity 5: Commence operations.

Sub-component 6: Billing and revenue collection system:
Activity 1: Design billing and revenue collection system and procedures.

Activity 2: Design and build billing and revenue collection framework and organization.
Activity 3: Set up accounting procedures and checks.

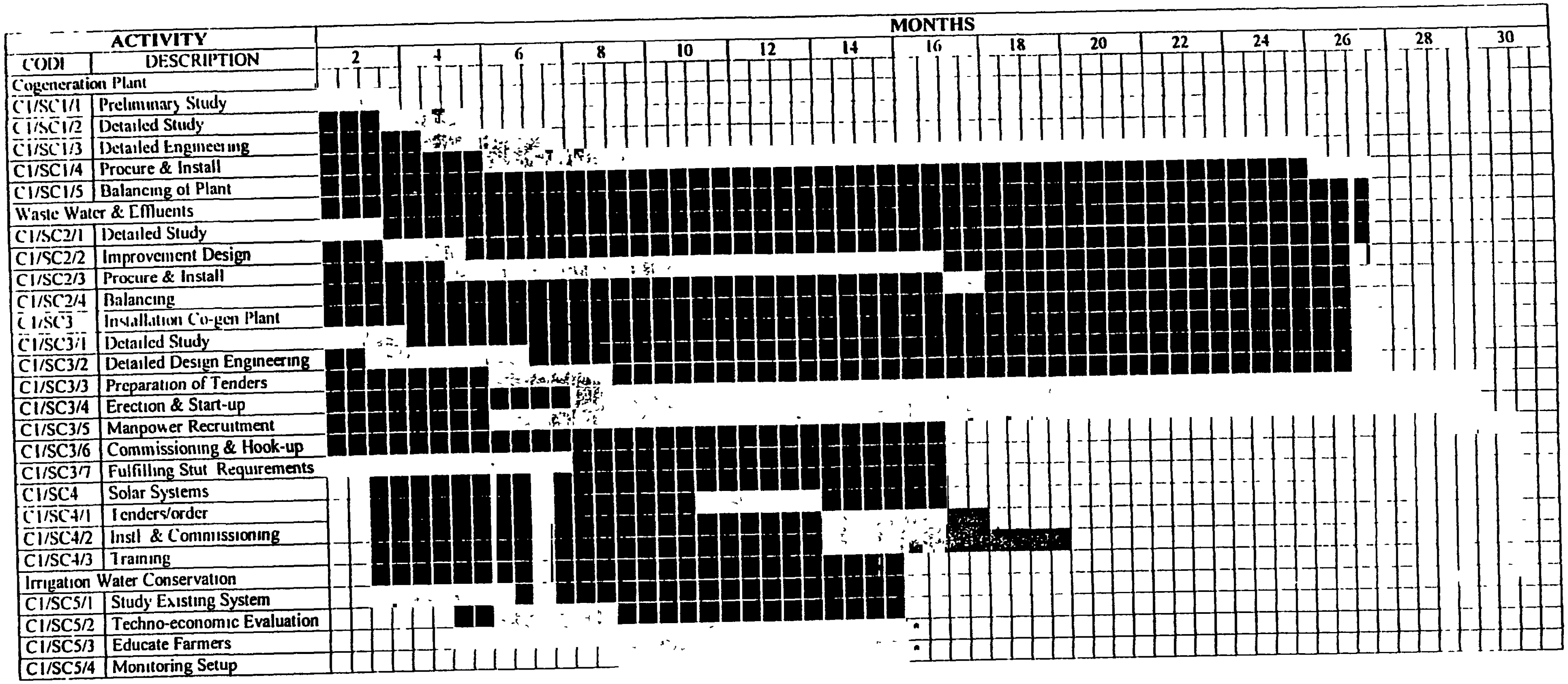
Sub-component 7: Set up consumer servicing network:
*Activity 1:*Design the system and mechanism for the servicing function including monitoring.
Activity 2: Design the organizational set-up.
Activity 3: Build and operate the system.

Component 3: Training and participation of active stake holders
Activity 1. Identify the stakeholders in the project.
Activity 2. Identify the opinion leaders, specially in the consumer category.
Activity 3· Organise interactions through group meetings to explain the concept and obtain their response.
Activity 4: Organise workshops to devise methods and strategies to ensure the active participation for success of the project.

Project activity schedule

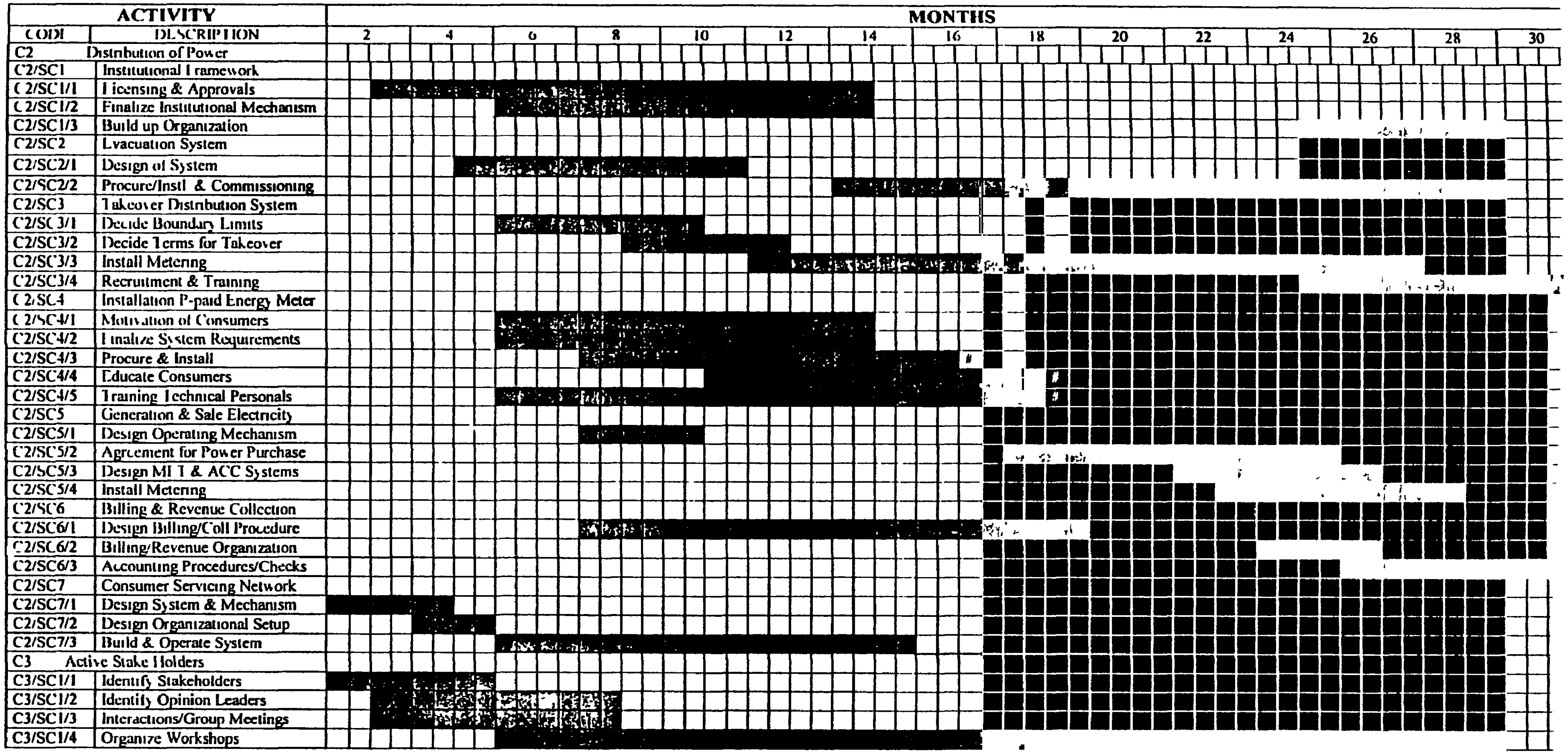
The cogeneration and distribution components of the project can be implemented in 30 months as indicated in the Project Bar Schedule

The demand reduction and control measures will be initiated simultaneously through the technique of Action Learning Project and completed concomitantly with the cogen plant and distribution set up.


ACTIVITY
CODE
DESCRIPTION
MONTHS
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Cogeneration Plant
C1/SC1/1 Preliminary Study
C1/SC1/2 Detailed Study
C1/SC1/3 Detailed Engineering
C1/SC1/4 Procure & Install
C1/SC1/5 Balancing of Plant
Waste Water & Effluents
C1/SC2/1 Detailed Study
C1/SC2/2 Improvement Design
C1/SC2/3 Procure & Install
C1/SC2/4 Balancing
C1/SC3 Installation Co-gen Plant
C1/SC3/1 Detailed Study
C1/SC3/2 Detailed Design Engineering
C1/SC3/3 Preparation of Tenders
C1/SC3/4 Erection & Start-up
C1/SC3/5 Manpower Recruitment
C1/SC3/6 Commissioning & Hook-up
C1/SC3/7 Fulfilling Stut Requirements
C1/SC4 Solar Systems
C1/SC4/1 Tenders/order
C1/SC4/2 Instl & Commissioning
C1/SC4/3 Training
Irrigation Water Conservation
C1/SC5/1 Study Existing System
C1/SC5/2 Techno-economic Evaluation
C1/SC5/3 Educate Farmers
C1/SC5/4 Monitoring Setup
*

* Review

1.11.2 Project Schedule Bar-Chart



CODE	DESCRIPTION
C2	Distribution of Power
C2/SC1	Institutional Framework
C2/SC1/1	Licensing & Approvals
C2/SC1/2	Finalize Institutional Mechanism
C2/SC1/3	Build up Organization
C2/SC2	Evacuation System
C2/SC2/1	Design of System
C2/SC2/2	Procure/Instl & Commissioning
C2/SC3	Takeover Distribution System
C2/SC3/1	Decide Boundary Limits
C2/SC3/2	Decide Terms for Takeover
C2/SC3/3	Install Metering
C2/SC3/4	Recruitment & Training
C2/SC4	Installation P-paid Energy Meter
C2/SC4/1	Motivation of Consumers
C2/SC4/2	Finalize System Requirements
C2/SC4/3	Procure & Install
C2/SC4/4	Educate Consumers
C2/SC4/5	Training Technical Personals
C2/SC5	Generation & Sale Electricity
C2/SC5/1	Design Operating Mechanism
C2/SC5/2	Agreement for Power Purchase
C2/SC5/3	Design MET & ACC Systems
C2/SC5/4	Install Metering
C2/SC6	Billing & Revenue Collection
C2/SC6/1	Design Billing/Coll Procedure
C2/SC6/2	Billing/Revenue Organization
C2/SC6/3	Accounting Procedures/Checks
C2/SC7	Consumer Servicing Network
C2/SC7/1	Design System & Mechanism
C2/SC7/2	Design Organizational Setup
C2/SC7/3	Build & Operate System
C3	Active Stake Holders
C3/SC1/1	Identify Stakeholders
C3/SC1/2	Identify Opinion Leaders
C3/SC1/3	Interactions/Group Meetings
C3/SC1/4	Organize Workshops

* Continued till 38 months

Review

2

Operational strategy and programmes

Introduction

The power requirement in the command area of STKWSSK is assessed in terms of consumer categories, number and estimated annual energy consumption. The proposed cogen scheme to optimise the power generation is described along with the schematic representation and outline features of the plant. Efficiency measures are proposed for improving the energy economy in the sugar plant, for energy conservation through water recycling in the sugar mill as well as improved effluent treatment and recycling methods to reduce the effluent load and adding value to the wastes in the mill complex. Better agricultural practices are proposed to conserve irrigation water and save on pumping power. Reforms are proposed in the distribution, aimed at reduction and control of demand. The institutional mechanism proposed for smooth functioning of the power generation and distribution in the command area as well as for committed involvement of consumers is described.

Power requirement in STKWSSK's command area

The electrical energy needs of the command area of STKWSSK are determined on the basis of the consumer categories and numbers and estimation of their annual power consumption based on analysis of the type of electrical loads for these consumers and their estimated usage.

Connected load

The total connected load in the area of command is

Number of villages : 63
Number of consumers : 60778
Of which - domestic : 33958
Non-domestic : 17414
Agricultural : 9406 (Individual)
Connected load (MW) : **87.60**

Lift irrigation load		
Number of societies	:	70
Number of farmers	:	9708
Connected load (MW)	:	**6.57**
Total connected load (MW)	:	**94.17**

Please refer annexure 1 for village wise details.

Energy consumption (MU)

The existing level of electricity consumed per annum in the area of command by different categories of consumers is estimated to be as follows:

Domestic consumption	:	67.747
Non-domestic consumption	:	5.503
Agricultural consumption (individual pump connections)	:	75.356
Agricultural Consumption *(Lift irrigation societies)*	:	15.756
Total energy consumption	:	164.362
Say	:	**164.4 MU**

Basis for electrical demand estimation

On the basis of the discussions with the substation level MSEB staff as well as with a few consumers of different categories randomly selected, the electrical demand in terms of units (kWh) has been computed using the following assumptions:

Domestic: On an average, 3 points consisting of lighting and TV used for 8 hours per day for 365 days, working out to 288 kWh per annum per consumer.
Fridge: 16 hours per day, 3456 kWh per annum.
Radio: 6 hours per day, 216 kWh per annum.

Non-domestic: Lighting, fan and TV at 10 hours per day, 316 kWh per annum.

Agricultural. This would comprise a) *Individual Pumps.* 3 HP pump at 8 hours per day for 300 days per year : 5280 kWh per annum. 5 HP pump at 8 hours per day for 300 days per annum . 10656 kWh per annum. b) *Lift Irrigation:* 70 Schemes, total 8800 HP. Per scheme 125 HP. It is assumed that these pump sets would work for 8 hours a day during night for 300 days a year. Total power consumption: 15755520 kWh per annum. (Please refer Annexure 2 for detailed computation).

Total estimated annual electrical load in the STKWSSK area of command: 164.4 MU

Optimal sizing of the cogeneration plant

The basic design considerations for the cogen plant are stated. The optimum sizing of the plant is described and the cogen schemes for generation during season and off-season are schematically represented. Proposals to procure maximum bagasse as fuel are presented. The surplus power available for distribution is computed. Outline features of the cogen plant including electrical system are described.

Basic considerations

The cogeneration plant will be bagasse based, proposed to be operated for a minimum period of 360 days consisting of 180 days of the cane crushing season and 180 days of the off-seasonal operation of the STKWSSK sugar plant. The plant will be designed to operate for a minimum of 8600 hours of operation per year. This plant should be capable of generating power which will be able to cater to the maximum possible electrical energy needs of STKWSSK's command area, besides meeting the entire process steam and power requirements of the sugar plant and the power requirements of its auxiliary plant and equipment.

Plant sizing

The plant has been sized on the maximization of the in-house bagasse availability and the sugar mill crushing rate of 8500 TCD (360 TCH).

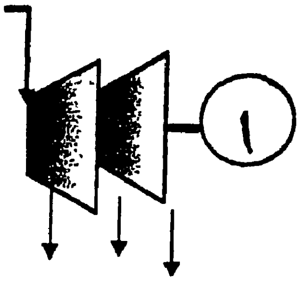
The cogen plant will have 2 turbines of 17.5 MW each. Based on the in-house bagasse and that available from the nearby sugar factories as well as the fluctuations in operation of the sugar plant, the cogeneration plant will give a gross output of 28.3 MW at the generator terminals during the cane crushing season and 17.5 MW during off-season. (only one turbine will be working). (Refer the Cogen schematics)

Cogen scheme schematic representation (season)

T/Hr 86.0

TG -1

ata 64
deg.C 500

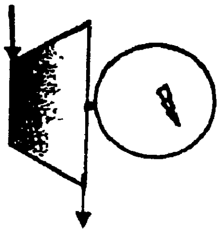


T/Hr	15.0	65.0	6.0	13	MW
ata	8	2.5	0.1	11	kV
deg.C	170	130	45	50	HZ

T/Hr 95.0
ata 64

TG - 2

deg.C 500



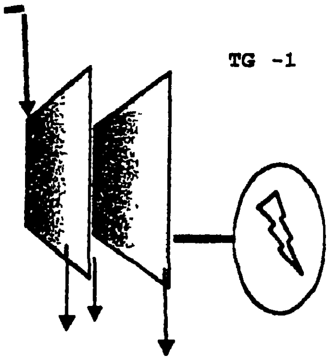
T/Hr	95.0	15	MW
ata	2.5	11	kV
deg.C		50	HZ

		Season
Cane crushing rate	TPD	8500
	TPH	360
Fibre percent cane	%	12.5
Bagasse production	T/hr	97
Bag Cons'n	T/hr	75
Bag saved	Lakh MT	22
Steam generation at		
67 ata 510 deg.C	T/hr	181
HP Steam distribution TPH		
New TG set-1		86.0
Mill & Fibrizer Turb		0.0
New TG Set -2		95
Process steam demand		T/hr
a) at 8.0 ata		15.0
b) at 2.5 ata		160.0
process steam generation		**TPH**
8.0 ata	New TG set	15.0
2.5 ata	TG set- 1	65.0
Mill & Fibrizer Turbines		0.0
	New TG Set - 2	95
0.10 ata to Condenser		6.0
Power generation MW		
TG - 1		13.3
TG - 2		15.0
--	**Total**	**28.3**
Plant load MW		**11 5**
Surplus power to grid MW		**16.8**

Cogen scheme schematic representation (off-season)

T/Hr 77.0
ata 64
deg.C 500

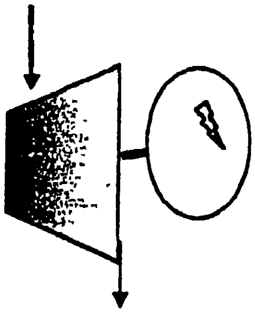
TG -1



T/Hr	6.0	6.0	65.0	17.5	MW
ata	8	2.5	0.1	11	kV
deg.C	170	130	45.45	50	HZ

T/Hr 0.0
ata 64
deg.C500

TG - 2



T/Hr	0.0	0	MW
ata	2.5	11	kV
deg.C	150	50	HZ

Cane crushing rate	TPD	0	
	TPH	0	
Fibre percent cane	%	12.5	
Bagasse production	T/hr	0	
Bag Cons'n	T/hr	31	1.22
Bag saved	Lakh MT		0.85
Bag purchased			0.37

Steam generation at

67 ata 485 deg.C	T/hr	77

HP Steam distribution TPH

New TG set-1	77.0
Mill & Fibrizer Turb	0.0
New TG Set -2	0

--

Process steam demand	T/hr
a) at 8.0 ata	6.0
b) at 2.5 ata	6.0

process steam generation		**TPH**
8.0 ata	TG set 1	6.0
2.5 ata	TG set - 1	6.0
	Mill & Fibrizer Turbines	0.0
	TG Set - 2	0
0.10 ata to Condenser		65.0

Power generation MW

TG - 1	17.5
TG - 2	0.0
Total	**17.5**

Plant load MW	**2.5**
Surplus power to grid MW	**15.0**

Bagasse management

By taking appropriate measures indicated in the bagasse moisture reduction, 97 MT/Hr, i.e. 378000 MT of bagasse can be made available in-house during the cane crushing season of the sugar mill. Out of this, 85000 MT can be saved for the off-season generation through the use of high efficiency high pressure boilers.

To maintain the optimum level of generation during off-season, a total of 122000 MT of bagasse will be required. Considering the in-house saved bagasse of 85000 MT, 37000 MT will be procured from the nearby sugar factories in the region. These factories are not proposing to go for own cogeneration on account of the size limitations. The total surplus bagasse availability from these factories is estimated to be 91000 MT as indicated in the following table.

Table 2.1 Potential bagasse availability from nearby sugar factories

Sl.No.	**Name of the Factory**	**Crushing Capacity (TCD)**	**Potential Available Bagasse (MT)**
1	Deshbhakta Ratnappa Kumbhar Panchaganga SSK, Ichalkaranji	5000	15000
2	Hutatma Kisan Ahir SSK, Walve	2000	9000
3	Kumbhi Kasari SSK	3000	18000
4	Shri Bhogawati SSK, Parite	4000	9000
5	Shri Chhatrapati SSK, Kolhapur	2200	15000
6	Shri Datta SSK, Asurle	2500	9000
7	Vishwas SSK, Shirala	1250	6000
8	Sharad SSK, Narande	2500	10000
	Total		**91000**

Note: The estimation of the bagasse availability is based on

i. Total crushing during season (average of last 3 years).

ii. Surplus bagasse at 3% on cane crushed.

Maximising the saleable power

The saleable power from the proposed cogen facility will be maximized by implementing the various energy improvement measures in the sugar mill as recommended through a plant level study (refer section on Energy efficiency improvements) and resource conservation and effluent/wastewater mitigation/recycling. (refer sections on Water recycling and Conservation through wastewater and effluent treatment)

These measures will limit the internal power requirements for both the sugar plant and the cogen plant auxiliaries (including losses) to 11.5 MW during crushing season and to 2.5 MW during off-season. Thus the power evacuated to the MSEB distribution system will be . 16.8 MW during crushing season and 15 MW during the rest of the year.

Since it is proposed to use the existing MSEB transmission and distribution network in the area of command, wheeling charges @ 2% will be levied by MSEB. Additionally, transmission and distribution losses of 5% of the transmitted power (as maximum permissible for distribution within 50 km radius Godbole Committee report) have to be considered. Thus the net power available for distribution and sale to the consumers in the area of command will be lower by 7%.

Power available for distribution in the area of command

Generation : 28.3 MW (180 Days in season)
17.5 MW (180 Days in off-season)

Captive Consumption: 11.5 MW (season)
2.5 MW (off-season)

Units Generated (at 80% PLF):

Season:	97.95 MU
Off-season:	60.36 MU
Total:	158.31 MU

Units Available for Distribution:

Season:	58.19 MU
Off-season:	51.72 MU
Total:	109.91MU

Cogen plant features

The main plant and equipment for the cogen facility will consist of steam generator and auxiliaries and turbo generator and auxiliaries. The complete plant will be designed to achieve the best possible efficiency under the specified operating conditions. The plant layout shall make optimum use of land (10 acres excluding bagasse storage area) and facilities to minimize the cost. (refer: Cogen plant schematic layout)

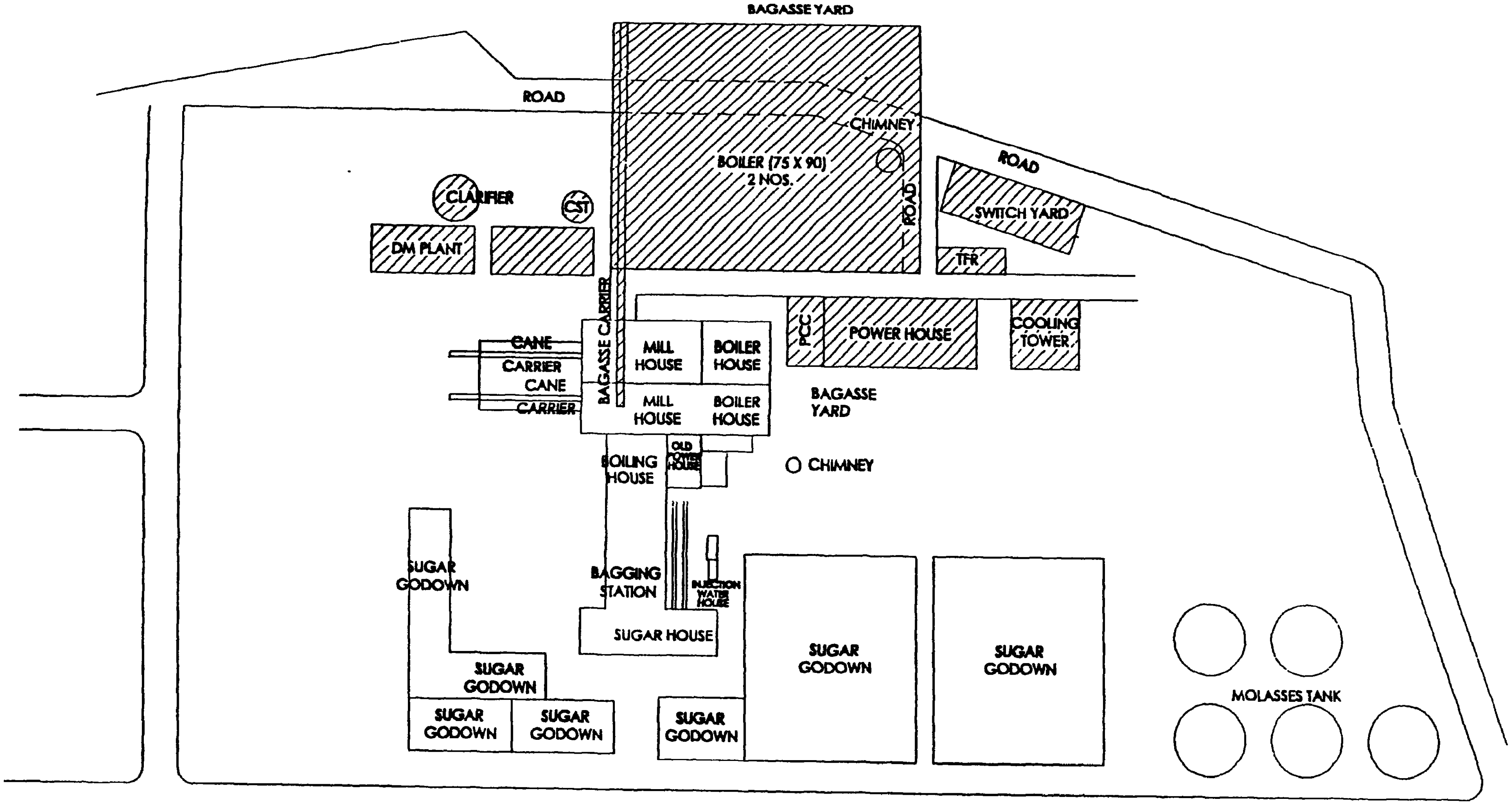
The voltage level of generation will be 11 kV and the saleable power will be stepped up to 33 kV and paralled with the existing MSEB grid at the Kodoli Sub-Station at a distance of about 1 km from the sugar plant. The internal consumption will be at 11 kV and 415 V.

Electrical system features

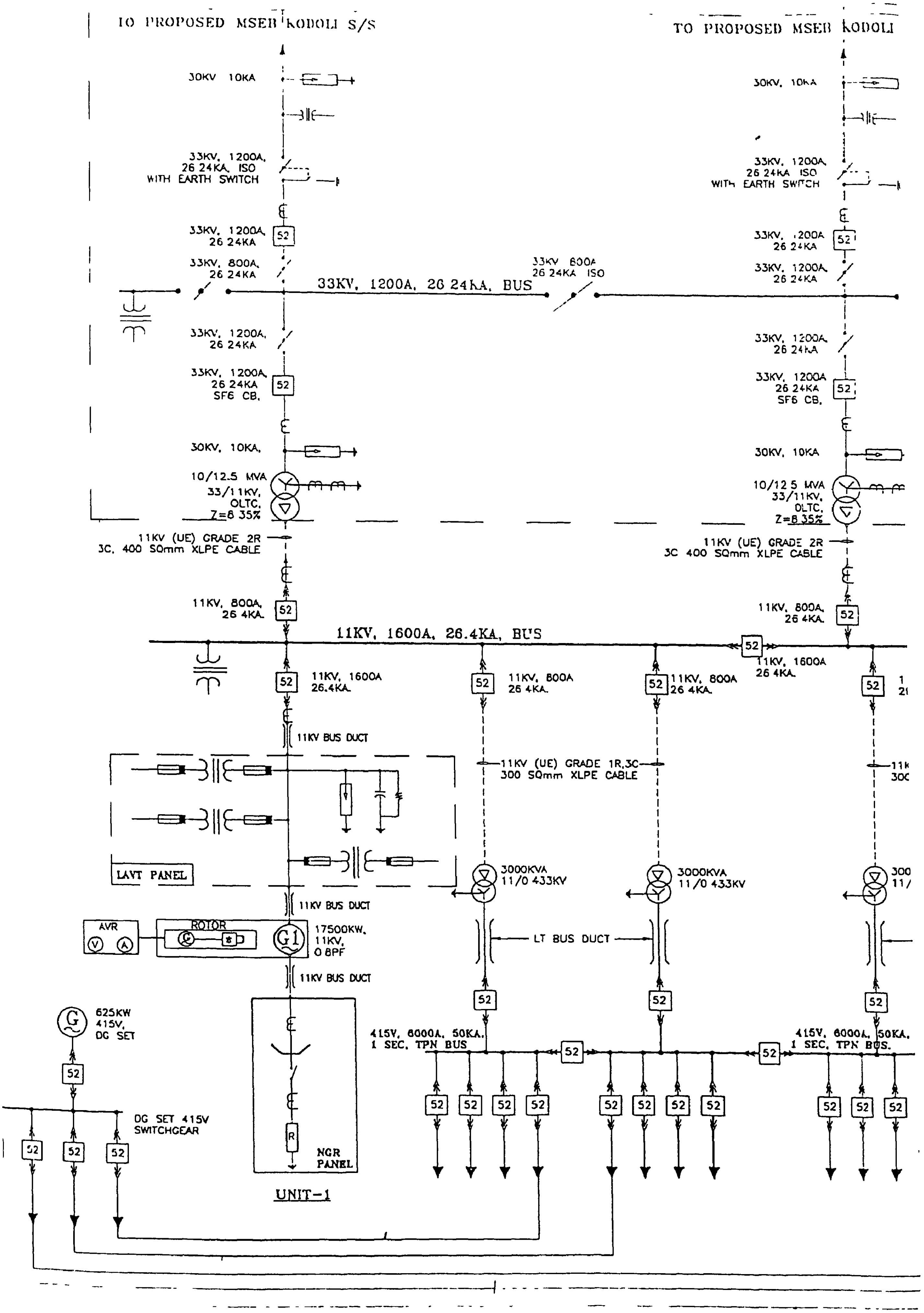
The system will include equipment and assemblies like generators, cooling system, generator transformers, 11 kV connection between generators and 11 kV switchgear, SPVT cable, 33 kV switchyard, station/sugar mill auxiliary supply, 415 V switchgear, emergency power system, UPS system, control and protection system, lighting , cabling, lightening protection, fire alarm system, communication system, safety earthing and lightening protection system, instrumentation and control for boilers and electrical system, etc. (refer key line diagram)

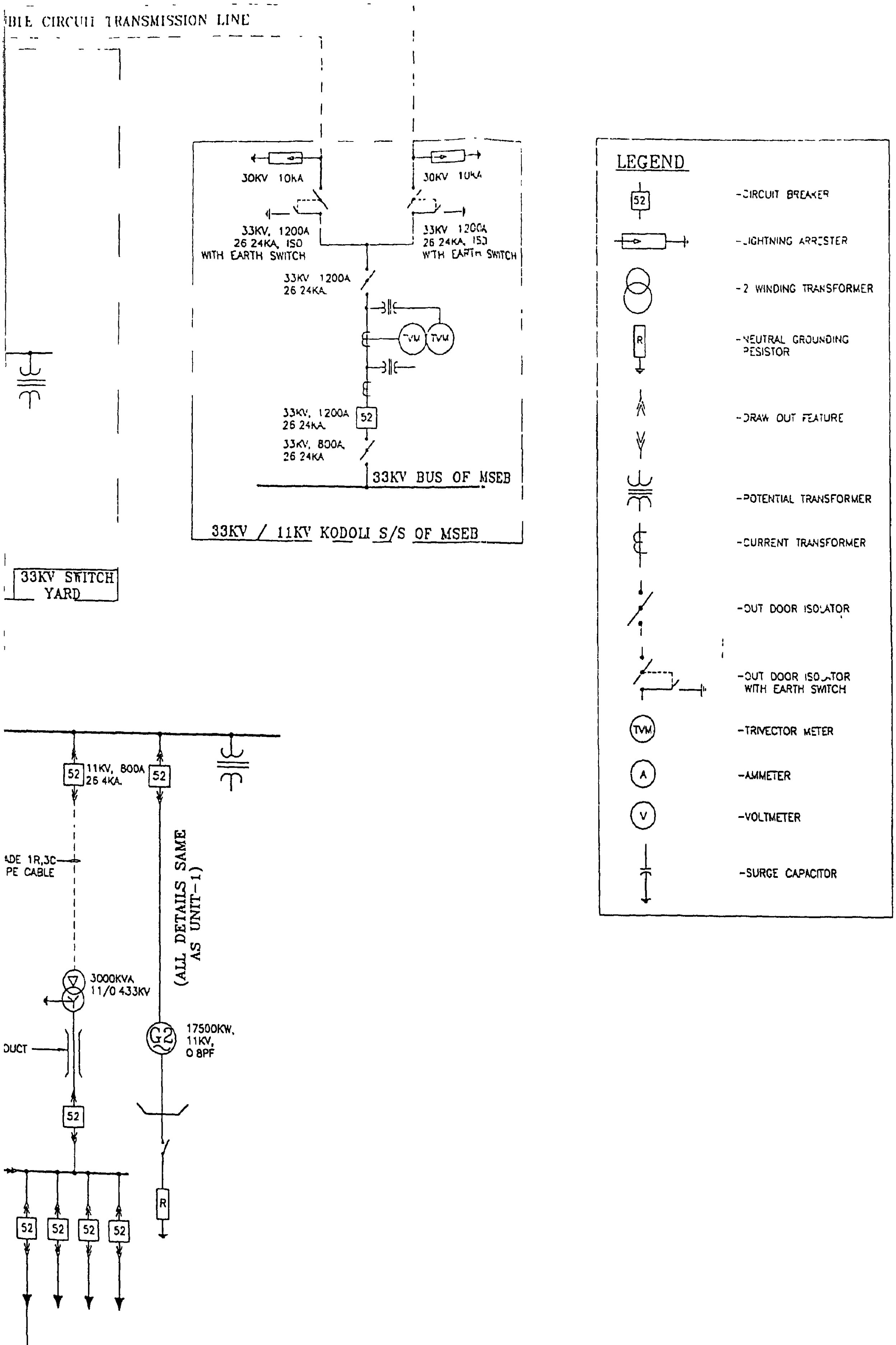
Power evacuation:

A double circuit 33kV transmission line will be installed between the power plant 33kV switchyard and Kodoli Sub-station, which is about 1 km from the plant. This line will be terminated onto the 33kV bus of the Kodoli Sub-station. The 33kV incomers from Vathar Sub-station will be retained. In case of any problems in evacuating the power from the cogen plant, then the emergency power can be drawn from the MSEB grid and distributed to the consumers. The paper plant will be supplied power through an additional 33kV feeder from the cogen plant switchyard. (Refer Annexure 3 for broad specifications of cogen equipment and electrical system).



CO-GEN PLANT LAYOUT - SCHEMATIC (NOT TO SCALE).


TO PROPOSED MSEB KODOLI S/S
TO PROPOSED MSEB KODOLI
30KV 10KA
30KV. 10KA
33KV. 1200A. 26 24KA. ISO WITH EARTH SWITCH
33KV. 1200A. 26 24KA
33KV. 800A. 26 24KA
33KV 800A 26 24KA ISO
33KV. 1200A. 26 24KA. BUS
33KV. 1200A. 26 24KA
33KV. 1200A. 26 24KA SF6 CB.
52
30KV. 10KA.
10/12.5 MVA 33/11KV. OLTC. Z=8 35%
11KV (UE) GRADE 2R 3C. 400 SQmm XLPE CABLE
11KV. 800A. 26 4KA.
11KV. 1600A. 26.4KA. BUS
11KV. 1600A 26.4KA.
11KV. 800A 26 4KA.
11KV BUS DUCT
11KV (UE) GRADE 1R.3C 300 SQmm XLPE CABLE
LAVT PANEL
3000KVA 11/0 433KV
AVR
ROTOR
17500KW. 11KV. 0 8PF
LT BUS DUCT
625KW 415V. DG SET
DG SET 415V SWITCHGEAR
415V. 6000A. 50KA. 1 SEC. TPN BUS
415V. 6000A. 50KA. 1 SEC. TPN BUS.
NGR PANEL
R
UNIT-1



KEY ONE LINE DIAGRAM OF ELECTRICAL SYSTEM

Energy efficiency improvement in the sugar plant

The study proposes several measures to improve the steam and power economy of the sugar plant based on suitable modifications in existing plant and process, as well as selection of high efficiency high pressure boilers and multi-stage turbines. In addition, measures to improve the fuel value of bagasse are also proposed.

Energy conservation measures

The equipment, system design and plant layout is planned to enable it to produce extra electric power after meeting its captive needs of steam for processing and motive electrical power to run all the machinery and equipment. With a view to get the maximum benefit from this development, the factory shall incorporate acute steam and energy saving measures in the existing machinery and processes as well as in the proposed cogeneration project. The power thus saved is available for distribution.

Steam economy: Sugar processing requires steam for heating and boiling at low pressures. The requirement of steam depends mainly on the evaporation and the vapour bleeding systems. Reduction in the process steam requirement will make available more steam for power generation.

Steam Consumption (% on Cane)	
Existing :	52%
Proposed ·	45%
Steam saved .	25.2 MT/hr
Additional Power Generation :	3.98 MW

This saving will be achieved by:

- The evaporation scheme proposed is quintuple effect type with vapour bleeding from second effect to all ABC pan boiling and 3rd body vapour bleeding to raw juice heating as part of its juice evaporating and boiling system. Thus, pans are serving as third effect of the evaporator system. Only about 2 % of the vapours from the evaporators go to condensers - ensuring minimum wastage of heat and water consumption at the condenser.

- Use of exhaust steam (against live steam) for pan washing, molasses conditioning etc. to save live steam for power generation.
- With the increased capacity in the evaporator station, which now is a bottle neck, the imbibition rate can be increased, thereby further improving the mill performance.
- Replacement of existing multi jet condensers by high efficiency condensers and pumps for the injection water.

Power conservation in mill: At present, STKWSSK uses inefficient prime movers (single stage mill turbines) for driving the mills. The exhaust produced per BHP per hour is 14 kg. The existing process is designed to use this exhaust completely. Otherwise the excess exhaust would have to be let out losing the condensate. a) *Proposed measures:* Use of high efficiency multi stage turbines to produce electricity, which in turn, will drive the mills. These turbines will consume much less steam : 4.7 kg per BHP per hour. To meet the exhaust requirement of the process, the turbo set will have to generate much more electricity than the captive requirement. This surplus power will be available for distribution. The specific measures will include;

- *Eliminate steam reduction:* The current practice of reducing 14.5 MT/hr steam through the use of PRDS will be changed to the one, where, this steam will be utilized in the power turbine and bled at the desired pressure. This will produce additional 1.5 MW power.
- *Boilers:* The existing boilers operating at 21 ata and 340° C have an overall efficiency of around 62%. Moreover, the system used gives a steam to power ratio of only 11 kg/kWh. High pressure (67 ata) boilers operating at higher temperature (510° C) give higher efficiency of around 70-71%. This is achieved by using energy saving equipment like moving grates/spreader stokers for efficient burning of bagasse, economizer and air heaters which enable heat recovery from flue gases to the maximum extent possible, efficient condensate return and feed water management system ensuring good quality water with minimum loss of heat. More power will be generated through improved steam to power ratio of 6.33 kg/kWh.
- *Vacuum System:* Installation of high efficiency condensers, which use considerably less water and thus pumping power, to maintain the required vacuum in the evaporators and pans This would also minimize the water sent for cooling in spray pond, thus saving further power.
- *Spray Cooling* The existing spray cooling of water required at the condensers needs considerable power, besides, the cooling is also not efficient. We

propose use of cooling towers of natural circulation, which consume less power and bring down the water temperatures to near about ambient temperatures. This low temperature water enables further reduction in water needs and thus pumping energy

- *Harmonics:* Harmonic filters of the required capacity will be installed in the system to ensure that the harmonics do not affect the quality of power

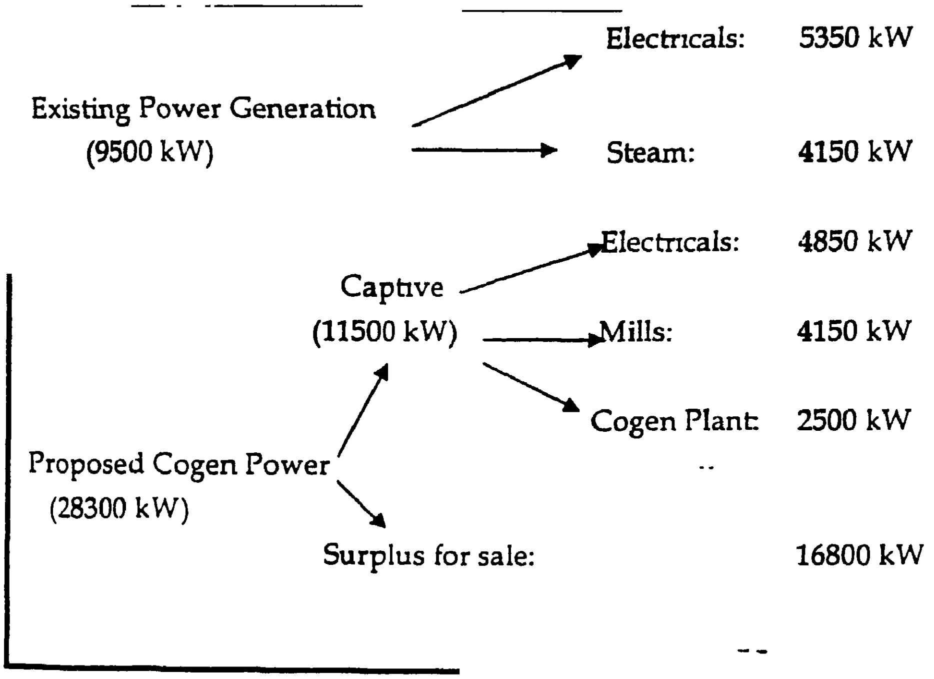
The net effect of these recommended measures will be to significantly reduce the power consumption of the sugar plant and increase the surplus power.

Overall power consumption of the sugar plant

Existing : 38 kW/MT cane

Proposed · 30 kW/MT cane

The final equation for power generation and distribution will then be;



Improving the quality of bagasse

The calorific value of bagasse is proportional to its moisture content. The boiler efficiency also increases with the reduction in moisture content. Hence all efforts will be made to reduce the moisture content of the bagasse. The present moisture content of bagasse is 50%. Whereas, it is possible reduce the moisture level to 48% through the following modifications:

- Automatic imbibation control: Keeping constant ratio of imbibation water to fibre.
- Continuous automatic measurement of bagasse moisture. Use of online moisture analyser on the last mill.
- Improvement in milling to get less moisture in bagasse at the milling.
- Automatic mill speed control depending on the fibre loading.

Improved bagasse utilisation for power generation ..

	Bagasse Consumption (MT/hr)	Steam generation MT/hr)	Power generation (kW/MT bagasse)
Existing*	79.5	175	57.6
Proposed	75	181	157.2

* Existing: part of the steam is used for mechanical power generation of 4150 kW.

Table 2.2 Recommended machinery for improvement in sugar plant

Equipment
Fibriser motor AC 2000 kW 11 kV
Mill DC motors 650 kW
Old Mill DC motors 220 kW
Torque monitor and speed control
On line moisture analyser
Imbibation automation
New evaporator for 2^{rd} body 2000 M^2 x 2
Modification of pan tube height
External entrainment separators
High efficiency condensers and pumps with automation
Cooling tower in place of spray pond
Cooling tower for surplus condensate water
Piping, instrumentation, insulation
Electricals for above
Civil works for above
Effluent treatment plant
Miscellaneous

Energy conservation through water recycling in the sugar mill

The present practice of sending the cooling water and condensate water to the drain is proposed to be changed for recycling the intrinsic water in the cane in the form of condensate, which will drastically reduce the fresh water requirement.

Existing situation

The Mill is presently using cooling water from the fresh water reservoir and most of this is sent to drain. In addition to above, the surplus condensate generated by the vapours of cane juice is also sent to drain. This increases the load on the effluent treatment plant and also results in loss of valuable water.

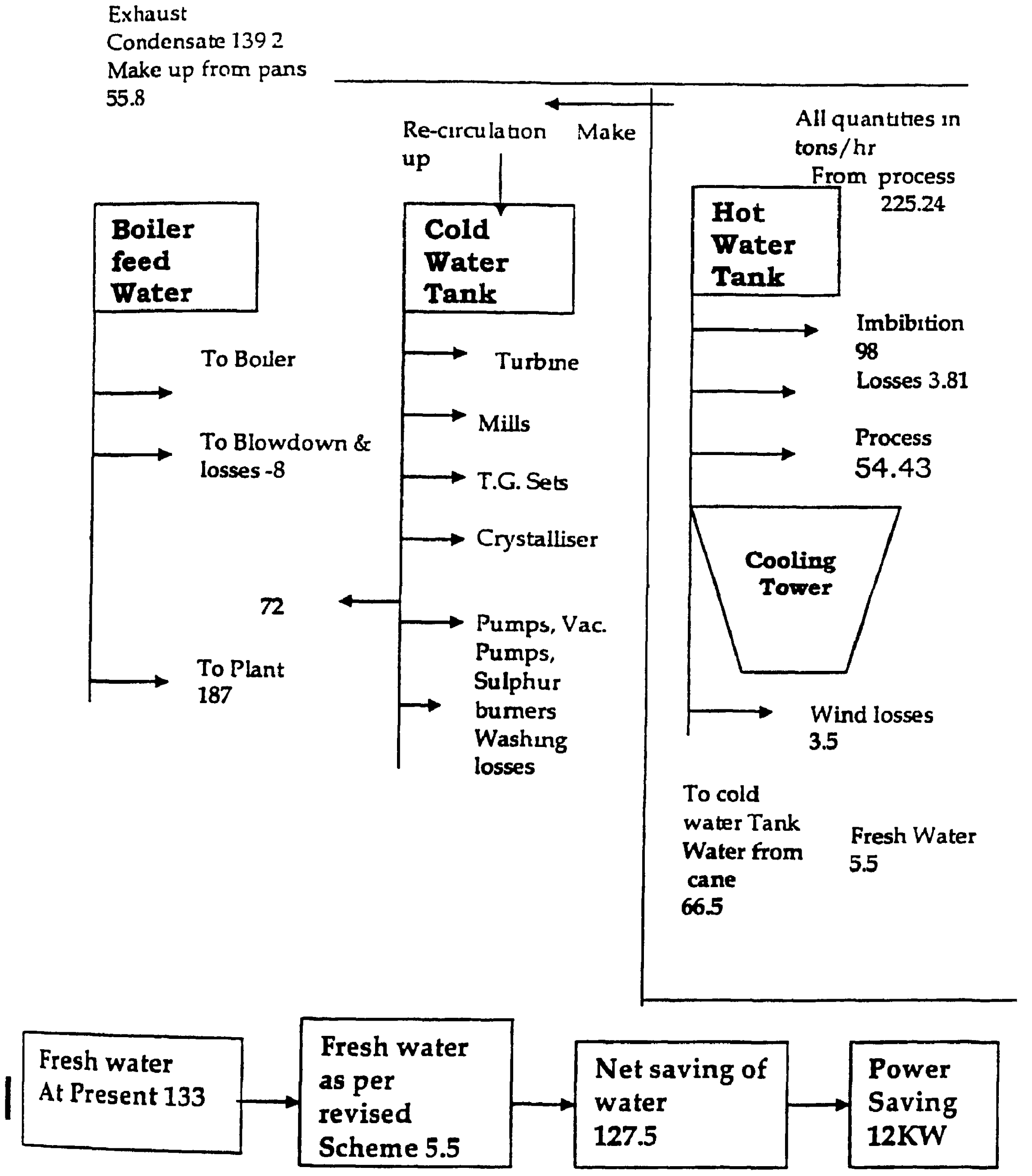
It should be noted that the sugarcane contains intrinsic water to the tune of about 65 - 70 %. Out of the 241 MT per hour of this water, 95 MT goes to the condenser and mixes with the spray water. Of the balance 146 MT, some quantity is used in the process, some is lost in evaporation and balance goes to the drain.

Proposed scheme

The uncontaminated water will be recirculated, if required, after cooling and filtering. Similarly, the condensate remaining surplus, after use in the process, will be cooled, filtered and used as make up for fresh water, since the quality of this condensate water is good. From the sugarcane water, we propose to recycle 66.5 MT per hour through cooling tower and filter, as make up fresh water.

These measures of recycling system, classification and reclamation of condensates together will reduce the fresh water requirement for the sugar plant by 127.5 MT of water per hour. This water conservation will result in a power saving to the tune of 12 kW per hour. (refer to the schematic of the proposed scheme)

HOT AND COLD WATER SCHEME



Conservation through improved effluent treatment

The existing procedures for treatment and disposal of effluents and waste in the sugar mill, distillery and paper plant are described along with the associated problems. Effective measures to mitigate the situation and to effect value addition are proposed.

Sugar mill

The generation of effluent and waste and the problems associated with their treatment and disposal are described along with the proposed measures for improvement.

Existing: At the average crushing of 1.2 million MT per season, the mill generates the following wastes and effluents(STKWSSK):

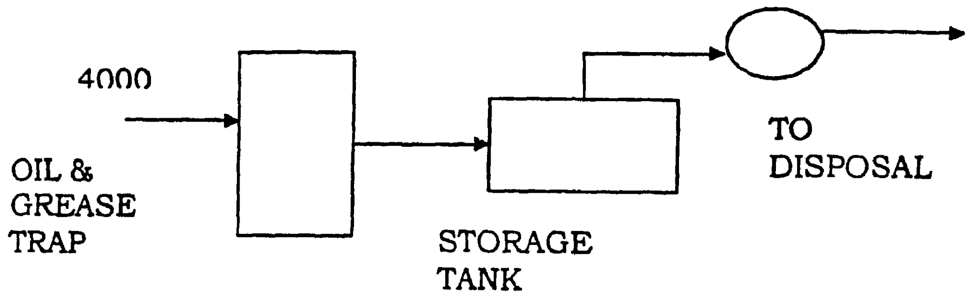
- *Press mud/filter cake :* 276 MT per day(3.2% on cane) or 38500 MT per season.
- *Liquid effluent:* The total water entering the mill system per day is 3200 cum of fresh/raw water and about 5800 cum of inherent water in the sugarcane (about 67% on cane). Of this, about 5000 cum is recirculated at present and the balance 4000 cum is drained as effluent.
- *Disposal:* About 16000 MT press mud is utilized in the co-composting plant along with the distillery effluent to produce compost. The balance 22500 MT is sold to the farmer members at a nominal price. However, the spreading of this press mud by the farmers in their fields gives rise to certain problems on account of its low compost value and tendency to block the soil porosity.
- The liquid effluent, after primary treatment (screening, oil and grease removal) is used as diluent for disposal of distillery and paper plant effluents for further disposal for irrigation.

Proposed.

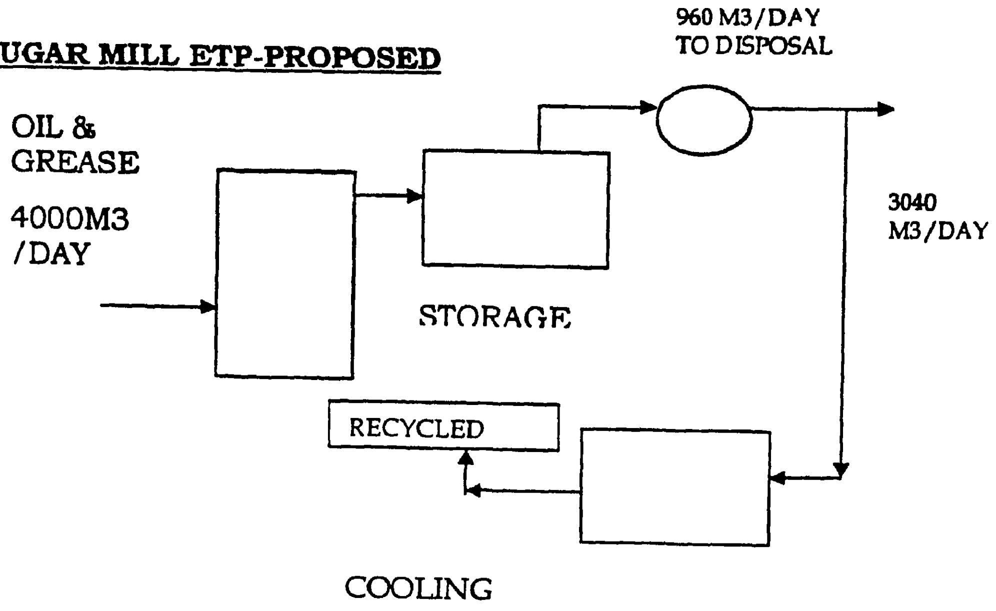
- *Press mud:* The measures proposed for the co-composting plant will utilise about 21000 to 26000 MT press mud. The balance quantity of 12500 to 17500 MT will be treated online with a special culture, which will enhance its compost quality, resulting into benefits for the farmer customers.
- *Liquid effluent:* As explained earlier in water recycling, of the existing level of 4000 cum per day of the wastewater, 3040 cum (127 cum per hour) will be recycled to the process after cooling and filtration as good quality water. This will reduce the wastewater volume to only 960 cum per day.

- In addition, measures like washing of lime grit and diverting the wash to condenser channel, collection of leakage of centrifugal house and floor washings and pumping it back to raw juice, using sugar contaminated condensates for maceration, reclamation of hot water, recirculation of all cooling water, good housekeeping and floor cleaning with bagasse, optimum sulphitation of syrup, installation of external entrainment separators for all pans and evaporators, installation of sugar dust collector and reuse of the dust, good water quality through DM plant to reduce blow down water, etc. will improve the quality of the above residual wastewater by reducing the effluent load to near zero. This will obviate the need to treat this water and it can be used as irrigation water with minimal primary treatment or even recycled to the mill.
- The only effluent in that case, will be the discharges from the occasional cleaning of the pans, evaporators and juice heaters amounting to about 500 cum per month during the season, which will be collected in a buffer tank and treated along with other liquid effluents. (from distillery and paper plant)

1:SUGAR MILL ETP-PRESENT



2:SUGAR MILL ETP-PROPOSED



Distillery

The shortcomings of the existing effluent treatment and disposal are highlighted and the proposed modifications with resultant benefits are described

Existing: The distillery of 25 KLPD capacity produces about 250 cum spent wash per day or about 52500 cum per year. This highly polluting effluent, after removal of yeast sludge and cooling, is sent to the biomethanation plant. The two bio digesters (Bio-Paq) are of UASB (Upflow Anaerobic Sludge Blanket) type. The bacteria present convert the biodegradable matter in the spent wash to methane rich biogas, about 8900 cum per day. This clean fuel with a gross calorific value of 4800 kcal /kg replaces 2 kg bagasse per cum, i.e. 17.8 MT per day or about 3750 MT bagasse per year.

The residual effluent after treatment is available for co-composting with the press mud from the sugar mill. However, on account of the limited area of the composting yard and the longer composting cycle of 7 weeks used at present, the maximum quantity of the effluent that can be utilised in the composting plant is limited today to about 32000 cum. The annual compost production is about 7500 MT at present, generating about Rs 3 million income for STKWSSK.

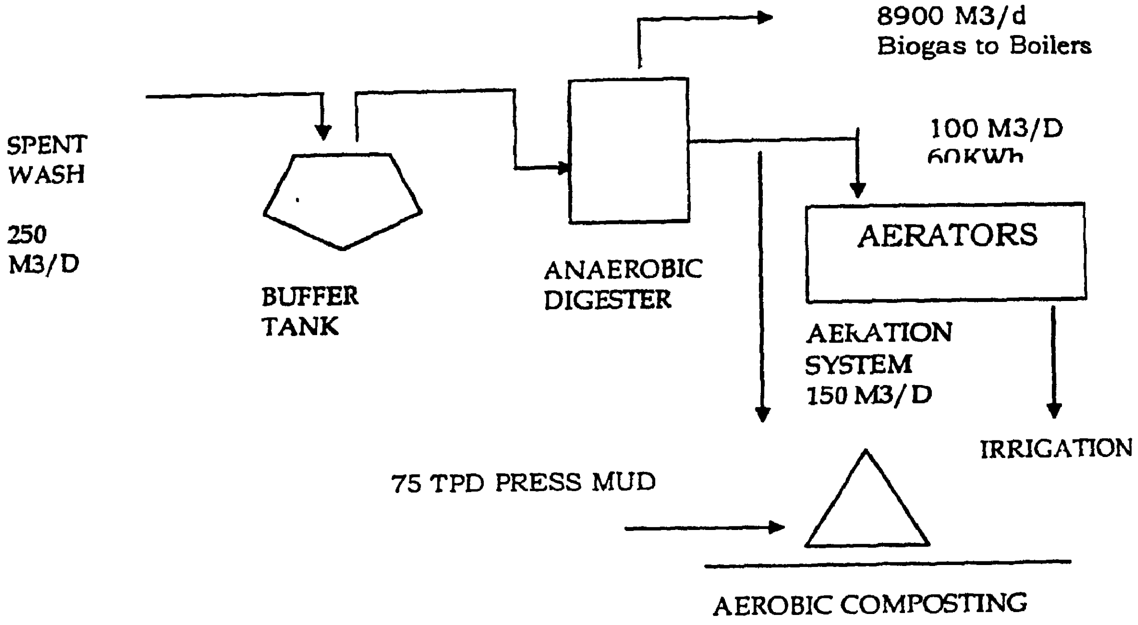
The balance 20500 cum of the effluent per year or about 98 cum per day has to be treated in the secondary stage using extended aeration and subsequently by the two stage aeration techniques, which consume about 60 kw per hour, i.e. 1440 kWh per day.

The treated effluent, about 2000 cum per day, is given a tertiary treatment and is then used for irrigation.

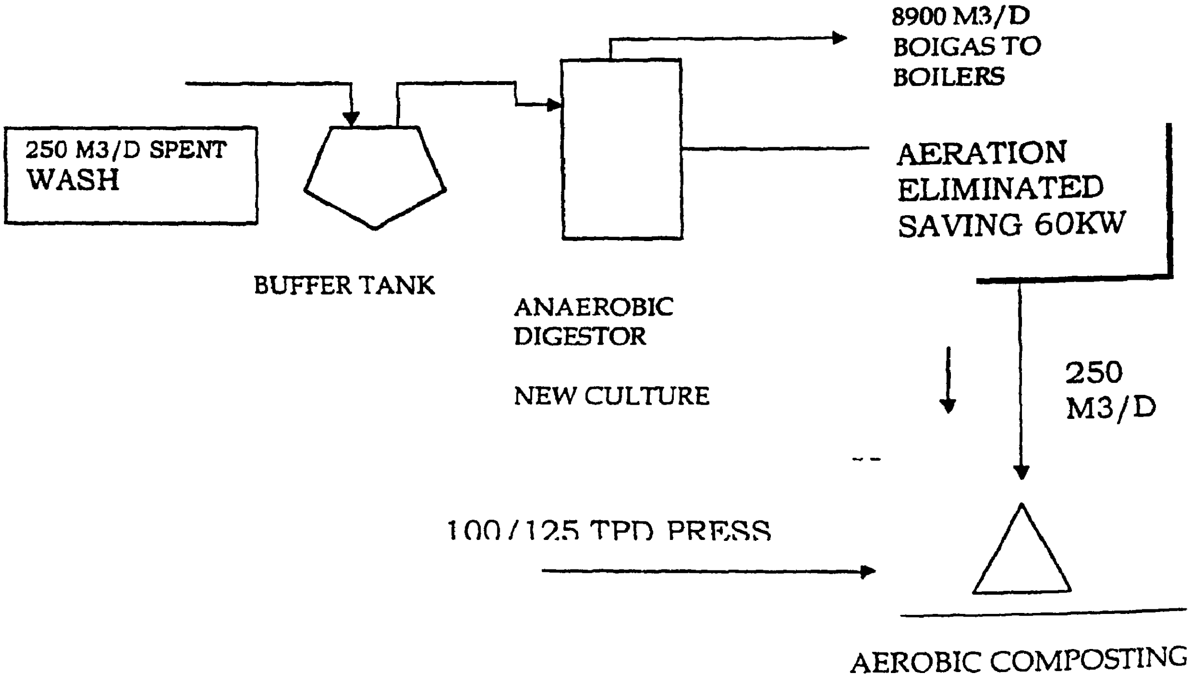
Proposed: New more efficient micro cultures will be used to increase the spent wash absorption capacity of press mud from the current 2 cum to about 3-3.5 cum of spent wash per MT of press mud, in addition to a reduction of the composting cycle from current 7 weeks to about 3-4 weeks.

These measures will enable complete utilisation of the spent wash effluent. This will eliminate the secondary aeration treatment, saving 1440 kWh per day of power and produce about 11500 MT of better quality compost. The additional 4000 MT compost will give an additional income of Rs. 1.6 million per year.

2:Distillery ETP-present



2:DISTILLERY ETP-PROPOSED



Paper mill

The major problems arising at present on account of the black liquor generation and disposal are propósed to be eliminated by the switching over to waste paper based system for the paper plant. The resultant benefits are highlighted.

Existing: The paper mill is based on the pulping of bagasse from the sugar mill and is designed to produce 20 MT per day of writing quality paper. However, it is operating at only 15 MT per day capacity on account of the effluent disposal problem. The mill uses 5000 cum of raw water per day requiring about 450 kWh pumping power per day.

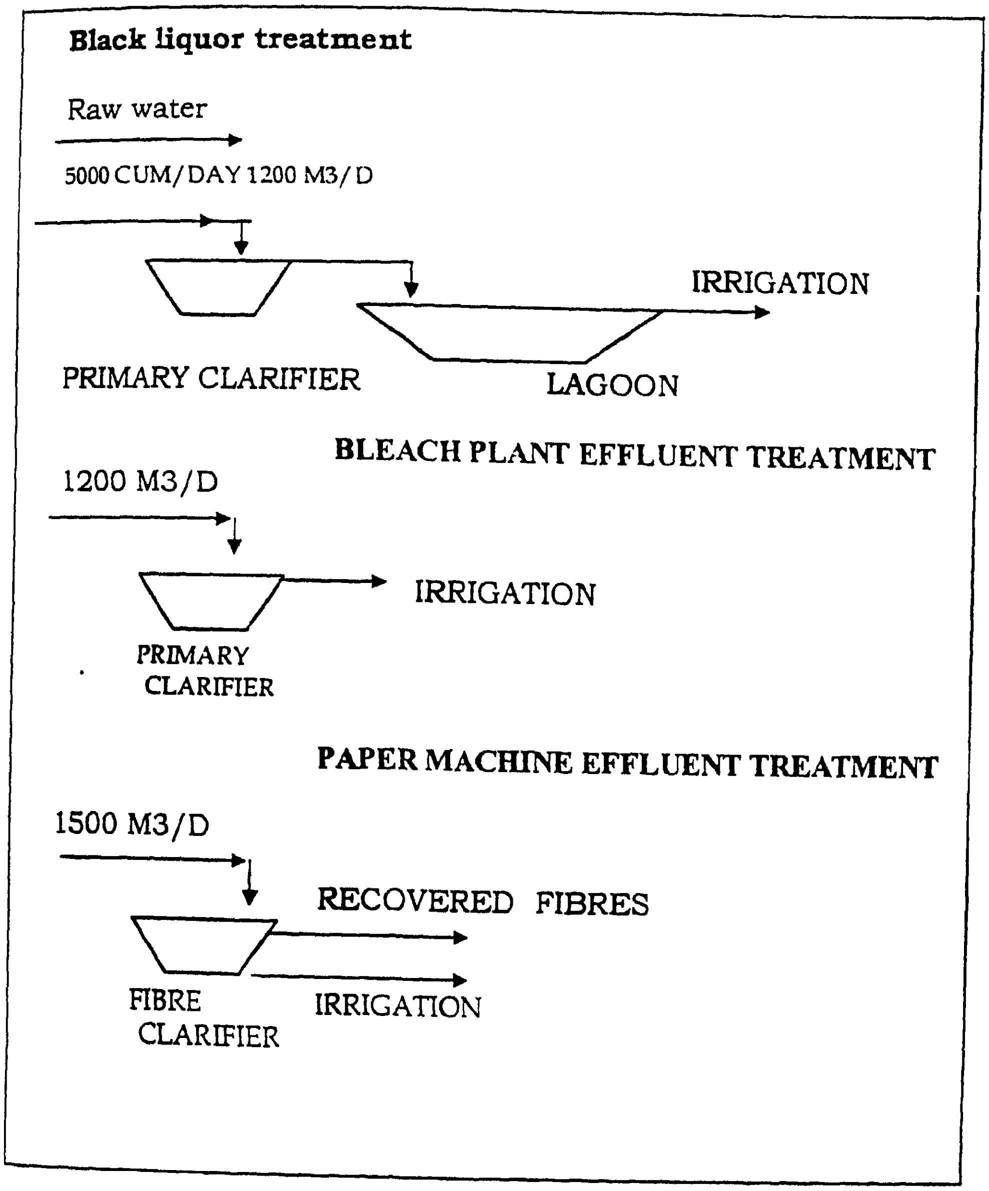
- *Effluents produced per day:* Black liquor - 1200 cum, Bleach plant liquor - 1200 cum and paper machine effluent- 1500 cum.
- The black liquor can not be treated in the biomethanation plant followed by anaerobic treatment on account of the heavy pollutant load. It has, therefore, to be diluted with other paper mill effluent streams as above, after primary clarification and then disposed off for irrigation. The dark colour of the mixed effluent however, makes it very difficult to convince the farmers to use it for irrigating their crop. This critical problem has severely limited the operation of the paper mill making it economically unviable.

Proposed: STKWSSK is considering several short term and long term options, which involve treatment of the black liquor for suitability of treatment in the biomethanation plant, treatment of bleach liquor for removal of chlorides and use it safely for irrigation, and recycling of paper machine effluent after recovering the fibres.

However, one measure being seriously considered is that of substituting the current bagasse based process to a waste paper based process. This will give the following benefits:

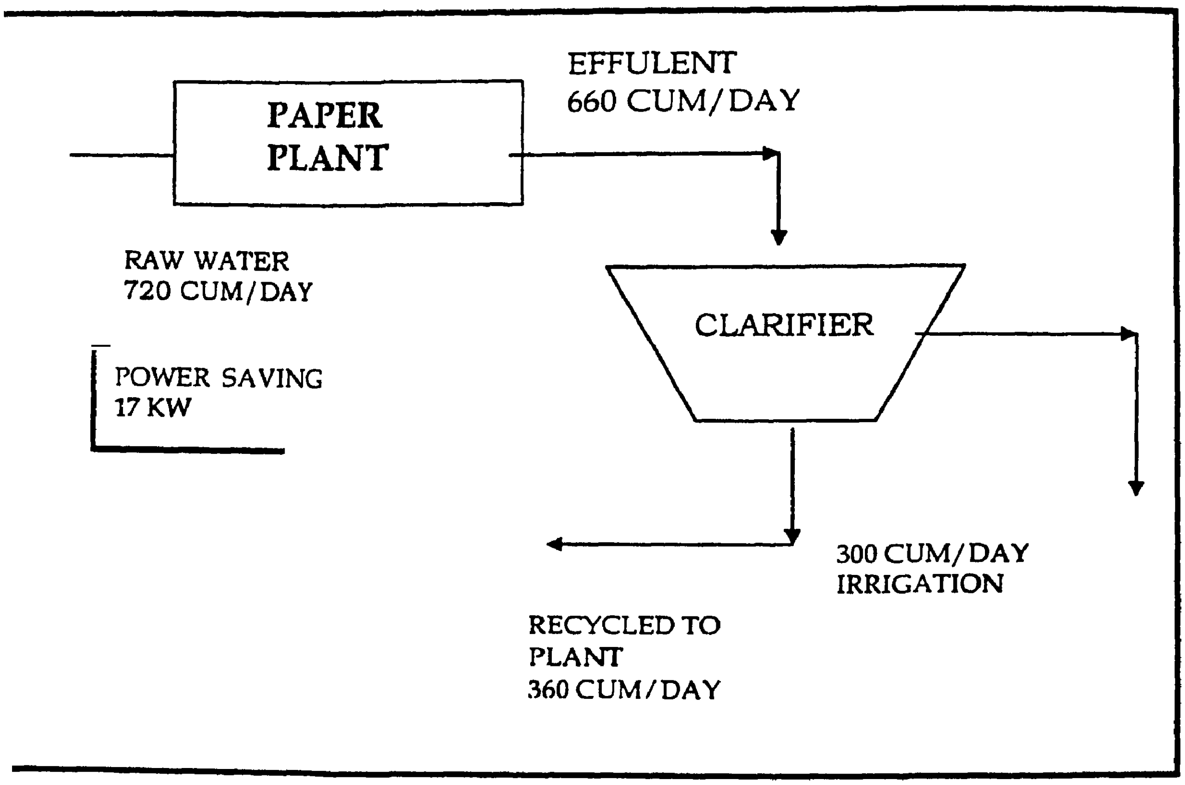
- Considerable reduction of raw water to about 720 cum per day from the current 5000 cum level.
- Complete elimination of black liquor.
- Easy primary treatment of the low pollutant load combined effluent and recycling to the extent of about 360 cum per day, reducing the net raw water requirement by 50% to 360 cum per day.
- Saving of raw water pumping power to the extent of about 415 kWh per day.
- Allowing profitable operation of the paper mill at a higher level of 30 MT per day, by enabling fuller utilisation of the drying capacity.

Paper mill ETP - present



Paper mill ETP - Proposed

- Black liquor treatment eliminated as waste paper based system proposed.
- Combined effluent from paper plant



Conservation of irrigation water and power

It is proposed to achieve a significant conservation of irrigation water and required pumping power in the command area through adoption of better and more efficient agricultural practices.

Status of irrigation in the command area

Total area under cultivation in the command area:
: 85737 Acres, of which
: 30587 Acres (36%) under Sugarcane
: 55144 Acres (64%) under other Crops

Source of Irrigation:

Lift Irrigation:	STKWSSK promoted:	15530 Acres
	Other lift schemes:	10500 Acres
Wells:		13500 Acres

Water Consumption:

Sugarcane:	160 Million cum
Other Crops:	65 Million cum
Total:	225 Million cum

(Based on current practices)

Thus sugarcane with 36% area under cultivation consumes 71% water, while other crops with 64% of the area consume only 29% water.

The actual water consumption for sugarcane may even be double as the farmers, on account of the flat rate for pumping power and the absence of any rationing on the use of water or power. It is understood that the water usage per MT of sugarcane may be of the order of 300 cum.

This excessive use of water by the flood irrigation (serpentine furrow method) is, apart from the rampant wasteful consumption of power, damaging the crop and the soil fertility, as evident from the high incidence of saline soil in the region and the reducing cane yield (about 60-70 MT/Ha).

Pumping Power Requirement:

Sugarcane: 64 MU (for actual 320 cum of water consumption)
(Basis: 5 kWh per 25 cum draw)

Proposal for irrigation water and power economy

We propose to achieve significant economy in the consumption of irrigation water by motivating the sugarcane farmers to change their cane planting pattern and irrigation techniques.

The Patta system of planting involves cane planting at 3 ft distance, with one blank row after every two rows. This results in the area under actual plantation being 2/3rd of the area by the currently used conventional technique. However, the yields are higher on account of better solar energy absorption. Moreover, the water requirement is lower by 1/3rd.

Another benefit of this system is, that it allows intercropping, ultimately improving the economy of the plantation.

With proper operation and maintenance schedules for the water pumps, their efficiency can be improved by 20%. Thus the potential for power economy can be nearly 50% of the current requirement.

Proposed water and power economy

- *Water conservation for sugarcane::* 106 Million cum/year (1/3rd)
- *Power saving:* 21.2 MU/year (8.88 MW)

Power saving/additional generation at a glance

(All quantities are per hour)

SUGAR FACTORY

1) Water conservation -12 kW
2) Steam economy measures
- Additional Power Generated - 3 98MW
3) Additional Power Generated
- Extraction Through TG Set - 1.5 MW

AGRICULTURE

1) Saving of power due to saving of water
2) Required by use of improved technique of cane plantation - 8.88 MW

DISTILLERY

1) Saving of power for aeration due
2) To improved composing - 60 kW

PAPER PLANT

1) Saving of power for pumping due to reduction of raw water requirement - 17 kW

TOTAL POWER SAVING/ ADDITIONAL GENERATION

- 14452 kw /hr
- SAY 14.45 MW

Reforms: distribution of power

The section discusses about the power distribution proposed by the project in the command area. It presents innovative approaches to bring about reforms in the process for reducing the peak demand and to exercise control on the demand

Proposed distribution

The manner in which the project proposes to meet the electrical demand in its command area is presented.

STKWSSK proposes to takeover the entire power distribution from MSEB in its command area. The project will also take up the reforms measures (described subsequently in this section) during the project execution to significantly reduce the peak demand in the area by 29.3 MU. The resultant total annual power demand of the command area will be 135.1 MU.

The project will have an annual surplus power of 109.91 MU at the generator terminals. The net supply will be 102.2 MU after considering the 2% wheeling charges to be paid to MSEB for transmission of this energy to the distribution point and the allowable distribution losses of 5% (for distribution within a range area of 50 km radius). With this capacity, the project will meet the above indicated net requirements in the command area as follows:

Distribution from own generation: (refer: Power requirement in command area)

▪ Total agricultural demand :	69.9 MU
▪ Domestic demand of the members of the co-operative (about 20000):	27.9 MU
▪ Total non-domestic demand:	4.4 MU
▪ Total :	102.2 MU

Distribution of MSEB supply: to remaining domestic consumers: 32.9 MU

Total distribution in the command area: 135.1 MU

The distribution system

STKWSSK will only go for the distribution license. The transmission up to the point of distribution network will be left to MSEB as at present.

The surplus power would be evacuated onto the Kodoli Sub-station 33 kV bus The 11 kV feeders from the various sub stations in and around the command area including the Kodoli Sub station are to be identified so that the total power can be distributed among the consumers in the command area. The 11 kV feeders so identified will be provided with energy metering for measurement of the number of units consumed by the distribution system.

The existing network and system of MSEB will be used on terms to be arranged. A detailed study will be undertaken to identify the weaknesses and specific improvements required in terms of distribution transformers and accessories, CT/PTs, conductors, protective switchgear, etc. for upgrading the network. The cost estimates could be available only after the detailed study.

Energy demand reduction in the area of command

To reduce the demand in the command area, innovative approaches are proposed of using renewable energy sources for lighting, in addition to the conservation of irrigation water earlier described.

Use of solar lighting:

Usage of solar photovoltaic cell based lighting systems is getting acceptance, albeit slowly, in the country Specially, it has been used in remote locations, where extending the conventional utility grid is difficult. It is proposed to use this source for lighting for the domestic consumers. This will not only reduce the demand and the peak load, but will use a totally clean renewable energy source India now has reputed solar lighting system manufacturers manufacturing to international standards, who would be in a position to supply the requirement.

- Domestic consumers: The project proposes to install at the residence of each of the 20000 members of the STKWSSK co-operative, a solar home lighting unit with 3 lights of compact fluorescent type along with the battery and charge controller with a capacity of 6 to 8 hours of operation per day.
- Non-domestic consumers: It is proposed to replace the street lights in the villages in th command area with a solar street lighting unit. It will have

solar modules of total 75 Wp, battery, dusk to dawn controller, pole and accessories to operate a single light throughout the night.

- Load reduction:
    - Domestic: Each solar unit will replace 3 bulbs of 40 watt estimated to be in current use at each household used for 8 hours a day for 365 days on average. Total energy consumed per year per household for lighting: 350 kWh. Total number of households: 20000. Total conventional energy saved/replaced: 7.0 MU per year.
    - Non-domestic: Each unit will replace a conventional rural street light of 100 watts running for 10 hours in the night, year round. With estimated 50 street lights per village on average for the 63 villages in the command area, there will be 3150 fixtures. The estimated conventional electrical energy consumption by these units of about 1.1 MU per year will be eliminated.

Irrigation water conservation: As described earlier in this chapter, the electricity consumption from the agricultural segment will be reduced by 21.2 MU per year through conservation of irrigation water by motivating the sugarcane farmers to switch over to the more economical and productive Patta system of plantation.

Saving of power through reforms

Agricultural power consumption:	21.2 MU
Domestic lighting:	7.0 MU
Street lighting:	1.1 MU
Total annual saving:	*29.3 MU (17.6%)*

Demand control

A new concept of energy metering is proposed for the first time in the country for effective demand control. Also, the proposed demand side management efforts are briefly mentioned.

Use of prepaid energy meters:

One major and often critical factor in a power utility's distribution is that of energy consumption over which the utility has virtually no control. This is more true in the case of agricultural consumers who enjoy unmetered supply The rampant use of pumps for irrigation during the night peak hours has often led to burgeoning of the peak demand

To overcome this factor, STKWSSK proposes to use " Prepayment Electricity Revenue System" for the agricultural consumers in its area of command. This proposal entails installation of prepaid energy meters for each agricultural consumer including the lift irrigation societies, in a phased manner during the project implementation.

This concept, proposed to be used for the first time in the country, will provide STKWSSK with a cost effective and reliable means of metering the electricity usage, collecting the revenue and managing the system properly to reduce electricity wastage and theft, improve its cash flow and also to provide the consumers with improved service.

For the agricultural consumers, this practice will help bring in the discipline and control on the consumption. It is a common observation that there is a natural tendency to use any resource without any control when it is cheap or free, but use it carefully and economically, when it is regulated and to be paid for up front.

The system would consist of a number of prepaid electricity meter types depending on the supply phases and current rating. The user will insert the prepaid card/ token in the meter to start the current and energy flow. The card will give a warning signal when a specified minimum of credit units are balance, to enable the consumer to buy another card in time to maintain the continuity of supply. Else, on expiry of the card the meter will automatically disconnect. The cards will also serve to transfer data between the meter and card vending unit. There will be hand held meter interface for field maintenance. A PC or server based management system which will be used to regularly upload the sales information from the card vending unit and to provide STKWSSK full management and control of the revenue system.

This system will eliminate the need to keep meter readers and skilled staff to connect and reconnect meters. There will be no requirement of account posting. Most importantly, this will eliminate bad debts from the agricultural sector.

The card limit will be designed on the basis of the average energy required for providing the economical irrigation water requirement for the crop, using the applicable energy flat tariff. A system can be devised to penalize the misuse/excessive use of power for irrigation, through higher tariffs for energy usage beyond the prescribed limit jn a given period. This will motivate the farmers to budget and plan the energy usage and, in turn use the water economically and judiciously. The system will offer them convenience of purchase, besides obviating the need for payment of reconnection fees.

This system will support the measures STKWSSK will take up for irrigation water conservation.

Demand side management: Another effective method to be adopted to control the peak demand will be introduction of overload tripping devices in the energy meters to discourage use of high energy consuming equipment such as water heaters, etc.

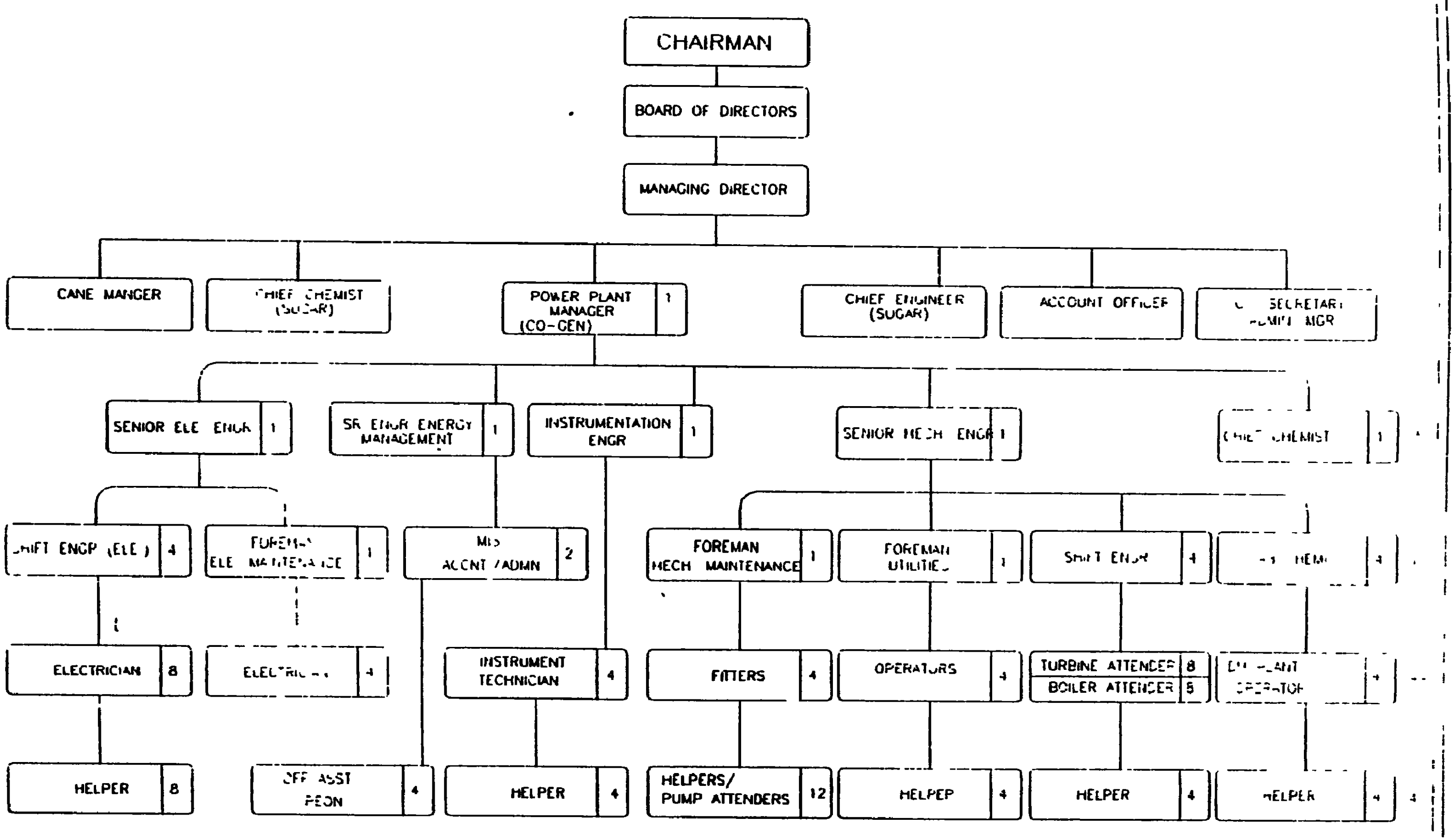
Institutional arrangements

This section describes the institutional and organisational mechanism and set up for the proposed co-generation and distribution of power in the command area. The arrangements to be made with MSEB in the initial phase are described and the approach for securing the committed involvement of consumers is recommended.

Licensing formalities

The license for generation will be obtained from MSEB under the relevant section of the Electricity Act. STKWSSK will develop an organization staffed with qualified and experienced professionals to man the co-generation plant (refer : Organization chart: power plant)

ORGANISATION CHART - POWER PLANT



1 ADEQUATE CONTRACT LABOR FORCE SHALL BE PLANNED FOR HELPERS AND FOR FUEL HANDLING LABORS

The license for distribution will be obtained from the Government of Maharashtra.

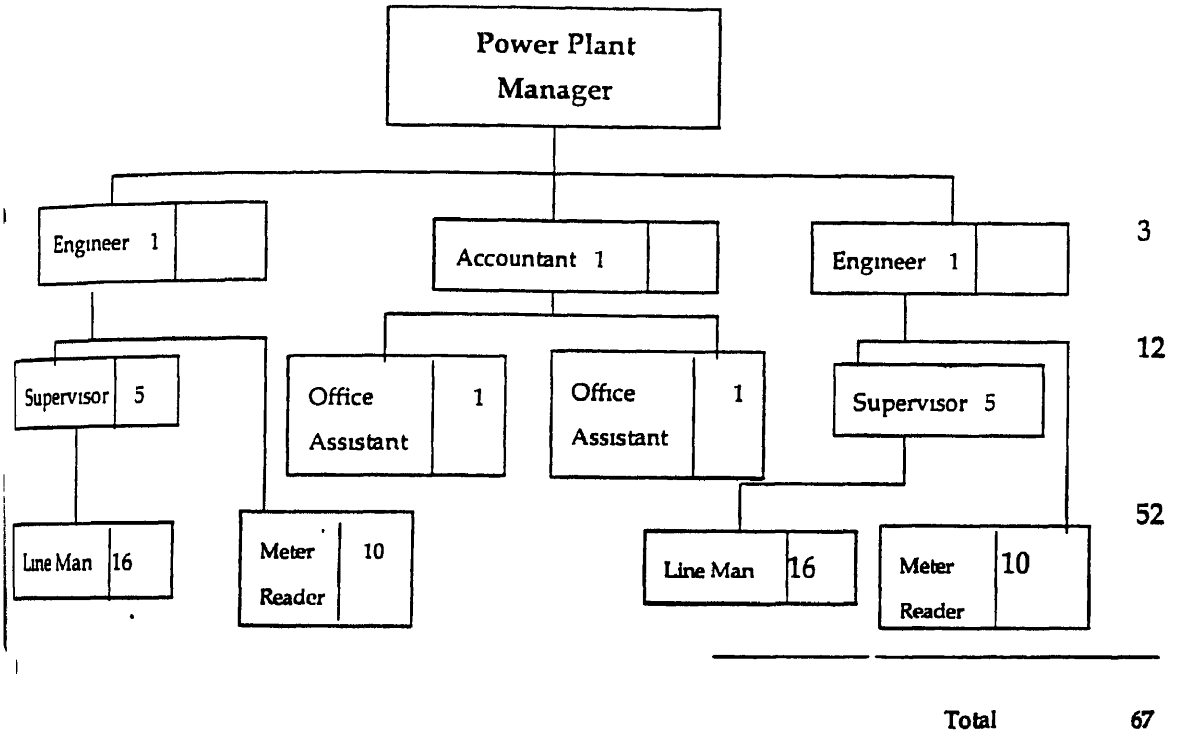
MERC's approval will be obtained for the supply tariff for the various consumer categories.

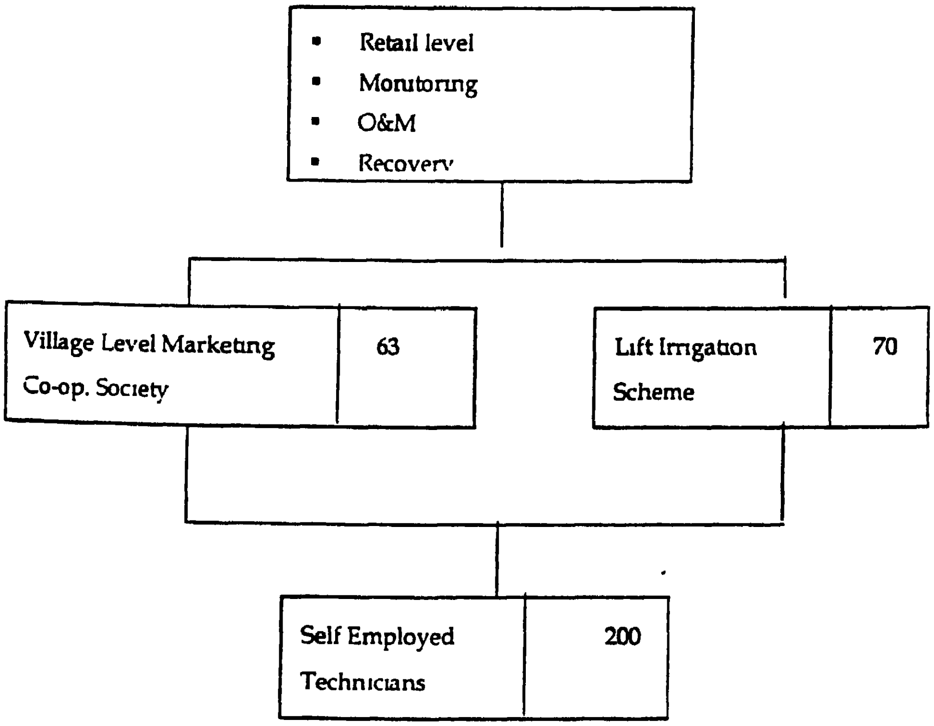
Arrangements with MSEB

As explained above, tie up with MSEB will be arranged for transmitting the evacuated co-generated power to the 11 KV distribution feeders. Arrangements will also be made to supply MSEB power to the domestic consumers in the area other than the co-operative members on commission bassis.

The technical generation staff of the project will be trained appropriately through MSEB. The local MSEB O & M staff will be retained in the first year for maintaining and operating the distribution system. During this period, the project's distribution and maintenance staff will be trained under the MSEB staff in O & M of the system, so that the entire operation and maintenance of the distribution system in the command area would be taken over from the MSEB personnel. (refer : Organisation chart: distribution)

Organization chart-Distribution




Retail level
Monitoring
O&M
Recovery
Village Level Marketing Co-op. Society 63
Lift Irrigation Scheme 70
Self Employed Technicians 200

Institutional set up for retail level distribution

To secure a committed involvement of the consumers in the project, it is proposed to distribute the power at the retail level through the existing network of lift irrigation societies for the agricultural consumers and village level energy consumer societies (to be formed) for the domestic and non-domestic consumers.

It is further proposed to generate self-employment for the local youth by organizing the distribution into consumer units of 50/100 KVA feeders and giving the charge of each such unit to a ITI trained youth. His responsibilities will include supervision and maintenance of the retail distribution of power in his unit, including monitoring and control for efficient usage as well as billing collection. Such technicians will assist the consumer societies. They will be trained appropriately and will be compensated by way of performance linked commission (e.g. trouble free operation of system within their charge, optimum use of energy, minimum wastage/pilferage, maximum recovery, etc.). This is expected to generate local self employment in excess of 200. Similarly, the societies also will be remunerated through performance linked commission. Appropriately designed incentive schemes for good performance will considerably help motivate these linkages to give better performance.

Financial engineering

The proposed financial structuring of the project is briefly put forth to ensure its financial viability in the light of the special circumstances underlying the proposed distribution in the command area.

Proposed financial arrangements

In case of MSEB, the supply to agricultural consumers at the low flat rates results in a loss for the utility, since the average cost of supply at Rs. 2.92 is much more than the average unit realisation of about Re 0.35 for the agricultural supply. This is the situation, when agricultural sector accounts for only about 15% of the total state load for MSEB In case of the proposed project, the situation will be worse, since the agricultural sector's share in the power requirement of the command area is about 55%. The net revenue for the project in such a case would be very low.

At the presently available funding for the cogeneration projects (SDF, IREDA, etc.), such a low income would make the project unviable.

In order to improve the viability, the project proposes to tap funds without any servicing and repayment obligations. It is proposed to seek funds from the Government of Maharashtra as a one time subsidy for financing the cogen plant and the sugar mill modifications Similarly, funds are solicited from international agencies like GEF for funding the proposed reforms for making the distribution more viable.

This financial engineering could minimise or even eliminate the financial burden on the project of providing for servicing and recovery of the capital costs. This would enable the project to supply the agricultural consumers at the current rate without jeopardising its financial viability. (refer : Chapter 5 on Project financials for more details)

Implications for MSEB

- Relief from the loss making supply of power to the agricultural sector in the command area. This capacity could be used by the utility for more profitable supply.
- The partial supply of domestic power to the non members of the co-operative through STKWSSK would be a viable proposition for the utility.
- MSEB will have to transmit the power evacuated from the project through the 33 kV feeder to the 11 kV feeders, the cost for which will be paid for by the project.
- MSEB will be required to continue the O & M of the distribution system in the command area for initial one year during which period, it will have to train at cost, the project staff in the O & M activity for the distribution network in the command area. (to be billed to the factory).
- MSEB's local O & M personnel could be redeployed in other suitable locations after the first training period is over.

3

Stakeholders

Introduction

The major stakeholders relevant to the objectives of the project are identified and the approach for bringing about their active involvement in the project is discussed.

Major stakeholders in the project

STKWSSK. The owner of the project, responsible for its implementation and operation and achievement of proposed benefits.

Government of Maharashtra: Provide funding for the cogen plant and modifications as one time grant from the agricultural power subsidy funds earmarked for the command area. Grant STKWSSK licence for distribution of power in the command area.

MSEB: Grant STKWSSK licence for bagasse based power co-generation. Transmit the co-generated power from evacuation point to the distribution points, allowing use of their distribution network in the area of command. Supply its power through STKWSSK to the non-co-operative domestic consumers. Maintain the distribution network in the initial/ transition period and provide training to the project staff, village level consumer societies and local technicians for O & M of the distribution system

MERC: Approve the project and fix the tariff structure for project's supply to the consumers in the command area.

UNDP-GEF/Other international funding agencies: Provide financial support for the incremental costs of the project covering the proposed reforms. Set up a mechanism for monitoring the project execution and evaluation of the benefits.

MoEF: Implementing ministry for the operational programme.

Commissioner of Sugar, Maharashtra State: Provide relevant permissions to STKWSSK as a sugar co-operative for taking up the project and provide support for procuring bagasse from adjoining sugar co-operatives for off-season generation.

MPCB: Provide NOC from pollution angle and permission to commence the operation. Ensure periodic pollution monitoring and control.

Consumers: Covering industrial units, farmers including members of the co-operative, lift irrigation societies, household, commercial and institutional consumers , etc in the area. Take up responsibility for efficient and economical use of the supplied power and making timely payment for its consumption.

Suppliers, contractors, consultants for the project execution: Quality and timely supply of materials, technologies, equipment and services for the project implementation.

Village level consumer societies: Proper distribution to the consumer members, monitoring the consumption, keeping vigilance to prevent energy theft and misuse, timely collection of bills from member consumers and payment to STKWSSK.

Local self employed trained personnel: Assist the village consumer societies in their responsibilities.

Local NGOs: Consumer enlightenment, consumer education and attitude change for proper use of energy and timely payment, educating farmers for economic use of water and adopting latest agricultural practices, vigilance to safeguard the interests of both the consumers and the project owners.

Stakeholder involvement

Workshops, group meetings and discussions and interaction on an ongoing basis will be organized to bring about active participation of stakeholders in the project as also through appropriate training inputs, particularly to the agricultural consumers in economical use of electricity through water conservation, to the village level distribution co-operatives in managing the energy consumption though metering and providing customer service through complaint cells, bill collection, etc.

A step in this direction has been already taken by organizing a brain storming session of the farmer consumers on 14th December at Warananagar. The feedback indicated a positive response to the concept of STKWSSK taking up the power generation and distribution The basic expectation focused on the need to get a quality supply at the current tariff. Also that the proposed project should be financially feasible, as specifically expressed by the farmer shareholders of STKWSSK.

4

STKWSSK - The project proposer

Background

Shri Tatyasaheb Kore Warana Sahakari Sakhar Karkhana (STKWSSK) was among the first sugar factories to be set up as a cane growers' cooperative in Maharashtra. The founder, Late Shri Vishwanath V. alias Tatysaheb Kore was a visionary. STKWSSK established in 1956, has grown from a 1000 TCD plant under the leadership and guidance of Late Shri Kore and subsequently of his successors ably supported by a dedicated professional staff, to a crushing capacity of 7100 TCD, among the highest in the country today.

STKWSSK has developed a remarkable industrial complex around the sugar factory. The major units are:

- Distillery: 25 Kilolitre per day
- Paper plant: Based on bagasse from the sugar factory: 20 MT per day
- Compost plant 30-40 MT per day utilizing the press mud from the sugar factory and spent wash from the distillery
- Warana Dairy: Processing capacity of 300000 litres milk per day, including 100000 litres milk processed into various products.
- Export oriented fruit pulp and puree plant (Shree Warana Agricultural Goods Processing Co-operative Society Ltd. - WAGPCOS). Set up with financial assistance from Credit Bank, N.V., Belgium

In addition, the society has promoted an institutional network of educational, training and commercial organizations in the area, making a deep impact on the lives of the residents in improving the quality of life.

Relevant experience

STKWSSK's technical staff is well experienced in the power generation and usage for captive requirements. (capacity 7 MW). As such, the factory has the core competence to operate the cogeneration plant.

The network of irrigation societies promoted by STKWSSK at village level in the command area will form the base for effective functioning of the proposed project.

5 Project financials

Introduction

The estimation of the various components of the bagasse based power co-generation and distribution project is explained. The incremental cost of the proposed reforms is then assessed. An innovative approach is described for funding of the project to make it financially sustainable. A typical working of the project is presented in the form of the profitability projections.

Project cost

The cost of the project is computed for the two major components of the cogen plant including the sugar plant modifications and the reforms.

Cogen component cost

The basis for estimation of the cogen and plant modernisation component cost is the information procured from reputed plant suppliers as well as the data available from most recent cogen projects.

The estimated cost of cogen component would be Rs. 1063.9 million.

Table 5.2 Break up of Cogen Component Cost

	Plant and machinery	Rs Mn
	Mechanical	
1	17.5 + 15 MW Turbines + Alternators	21.00
2	Boilers (2x100 TPH @ 67ata, 510deg C)	240.00
3	Fuel & Ash Handling System	45.00
4	Induced Draft 3 Cell Cooling Tower	4.50
5	CW Pumps, Valves & Pipes	5.00
6	D M Plant with Storage Tanks	15.00
7	HP & LP Steam Piping with Valves	15.00
8	Compressed Air System	4.00
9	Air Conditioning & Ventilation System	4.00
10	Misc Pumps	3.00

High Pr Feed Water Heater with Valves	6.00
Maintenance Tools & Tackles	2.50
EOT Crane	3.50
DG Set 750 kVA	5.50
Sub total	563.00
Electricals	
Electrical & Instrumentation	50.00
Essential Spares	15.00
Erection	40.00
Sub total	668.00
Taxes, Duties, Freight, Ins, etc	100.50
Civil+Bldg's+Fdn's	100.00
Contingency	65.00
Misc Assets	25.00
Pre-operative Expenses	12.00
Working Capital Margin	18.60
Sugar mill modernisation	75.00
Total cogen cost	1063.90

Cost of reforms

Table 5.2 Cost break-up

Sl. No.	Description	Quantity	Unit Rate (Rs.)	Cost (Rs.Mn)
1	Prepaid energy metering system	12000	10000	120.00
2	Solar home lights	20000	18000	360.00
3	Solar street lights	3150	28000	88.20
4	DPR and engineering			8.00
5	Training			10.00
	Total			**586.20**

Total cost of the project (Rs. Million)

• Cogen and sugar plant modernisation:	1063.90
• Incremental cost of reforms:	586.20
• **Total:**	**1650.10**

Incremental cost assessment

This section presents the baseline scenario for the project components considered and the changes to be brought about by the project components; with the incremental costs associated with the components.

Project Components	**Baseline Scenario**	**Alternative Scenario**	**Increment**
1) Setting up bagasse co-generation power plant for generating 28.3 MW and distributing surplus energy of 102.2 MU annually after meeting the in -house requirement in the command area of the sugar factory	Sugar factory producing 9.5 MW power only for captive consumption. Power supply and distribution in the command area is by MSEB.	Latest technology for setting up a modern bagasse co-generation power plant having 16.8 MW surplus power during season and 15 MW during off-season for export in factory's command area. Use of entire excess bagasse for power generation.	Waste bagasse utilized making available 102.2 MU of energy for the full year, providing relief to MSEB's strain on power supply. Sugar plant up-gradation to reduce in house power requirement and improving product quality.
Costs			
• Co-generation plant capital	**Rs**. 0	**Rs** 988.90 **Mn**	**Rs**. 988.90 **Mn**

investments • Up-gradation of existing plant capital investment **Total**		**Rs.** 75.00 **Mn** **Rs.** 1063.90 **Mn**	**Rs.** 75.00 **Mn** **Rs.** 1063.90 **Mn**
These funds will be arranged by STKWSSK from their own resources and mobilisation of funds through outright grant from Government of Maharashtra			
2: Alternative energy source i.e. solar energy utilization for home and street lighting	No such activity exists.	Solar systems will be installed during project execution stage and shall effectively function from start of project. 8.1 MU of energy would be tapped from this source to reduce demand from distribution system.	20000 homes and 3150 street lights of all 63 villages will become totally independent and self-sufficient for lighting. Low maintenance and recurring costs.
Costs			
• Home lighting • Street lighting **Total**	**Rs.** 0	**Rs.** 360.00 **Mn** **Rs.** 88.20 **Mn** **Rs.** 448.20 **Mn**	**Rs.** 360.00 **Mn** **Rs.** 88.20 **Mn** **Rs** 448.20 **Mn**
3: Institutional arrangement for generation of power from bagasse.	Sugar plant producing and providing power for captive consumption only by utilizing regular factory staff.	Institutional linkages will be set-up for operation of the power generation plant through a separate division in the sugar factory. Training to be provided through MSEB.	Capacity developed for generation of 102.2 MU of saleable energy per year and utilization of solar energy to the extent of 8.1 MU
Costs			
• Training	**Rs.** 0	**Rs.** 5.00 **Mn**	**Rs.** 5.00 **Mn**
4: Institutional arrangement for distribution of power, O & M and revenue collection	Power distribution is under MSEB.	Institutional arrangement will be set up with an object to take over distribution of power in the entire as also its revenue collection. MSEB staff will impart proper training during first year of operation	Electric power distribution to the area will be totally decentralised. Uninterrupted and quality supply in the area. Improved revenue collection
Costs			

• Training	Rs 0	Rs. 5.00 Mn	Rs. 5.00 Mn
5: Distribution of 32.9 MU of MSEB power to remaining domestic consumers on behalf of MSEB	Entire power distribution by MSEB	Power distribution agreement with MSEB	Ready for distribution of power in the entire command area.
6: Enabling mechanism to link power generation with proper distribution and maintenance involving stakeholders for their benefit. •	Target beneficiaries have no involvement and in the absence of any control of efforts at inducing optimum use of power and water, the available power and water supply are excessively used.	Village level co-operative societies will be trained to supervise and control at village level, the power distribution, its optimum usage and creating awareness among uses of the benefits to the society and individual stakeholders in adopting these activities. Self employed technicians to assist these societies.	Conservation of water and its release for other use. Reducing burden on MSEB and government by relieving it from its responsibilities to supply power to the area at un-remunerative rates requiring large subsides. Local self-employment generation for more than 200 numbers.
7: Global environmental benefits	Un-metered and low cost supply of power to agricultural sector has led to excessive use of both power and water for irrigation leading to increase in salinity of soil and low fertility. Thermal power generation leads to GHG emission on a large level.	Metered power shall bring discipline in use of power and water for irrigation, thereby saving the land from getting saline and unproductive. Project will motivate and train sugarcane farmers to switch over to alternative cultivation techniques, which will consume much less water and be more productive	Decrease of irrigation water requirement from 320 MCM/year to 214 MCM/year Improvement in soil condition, which has deteriorated due to excessive watering. Significant GHG emission saving will be attained through avoided emission of 29338 tons of CO_2 annually. CO_2 mitigation cost of US$ 2.64 Mn per year is saved (calculated @ US$ 90 per ton)
Costs			
• Prepaid metering system	Rs. 0	Rs. 120 Mn	Rs. 120 Mn
8: Domestic benefits	Rural population is in	Availability of quality power to	Sustainable socio-economic

	disadvantaged area and is deprived of quality and uninterrupted power supply. As per MSEB there is daily 90 MW load-shedding in Kolhapur district.	the community and farmers from renewable energy source.	growth of region with improved agricultural production due to better crop management and improved soil quality is possible.
Reduction of T & D Losses through localized generation and distribution.	Burgeoning T & D losses at nearly 40% which are due to energy thefts, wastage & transmission over long distance from generation point.	Cogenerated power will be distributed over relatively short range, controlling the technical losses to maximum 5%. Use of prepaid energy meters and the institutional mechanism of local level consumer societies will prove a deterrence for energy theft and wastage.	Improved sense of involvement and belongingness. Prepaid energy revenue system will improve the liquidity and reduce man power for meter reading and maintenance.

Project budget

The project funding is divided into two parts: a) the cogen plant and sugar mill modernisation and b) the incremental costs of reforms.

Table 5.3 Project Funding break-up (Rs. Million)

Component	Cost	Funding Source	Amount
Cogen plant and sugar mill modernisation	1063.90	STKWSSK (10%) Government of Maharashtra (90%) Total	106.39 957.51 1063.90
Reforms	586.20	GEF/Other international agencies	586.20
Total	**1650.10**		**1650.10**

Special funding considerations: The financing pattern proposed for the project takes into consideration the need to maintain its financial viability in the light of its proposed distribution to the agricultural sector in the command area at the very low flat tariff.

The contribution from the Government of Maharashtra, for supporting the cogen component, is proposed to be made as a one time grant from the power subsidy it is paying to MSEB for its agricultural supply in the area. The quantum sought is less than the subsidy amount for 5 years @ Rs. 220 million per year.

The reforms components are sought to be funded in the form of grants from GEF or any other international agency.

Financial viability of the project

A simple check on the financial viability of the project is carried out through the profitability projections of the project operations. The key assumptions underlying the computations are also given.

Revenue from distribution of electricity

The revenue would come from the distribution of own generated power and the MSEB power distributed on their behalf.

Revenue calculations(Rs. Million)

• ·From own generated power:	
▪ Agricultural sector: 69.9 MU @ average Re.0.49/kWh:	34.46
▪ Domestic load of members: 27.9 MU @ Rs. 2.50/kWh:	69.75
▪ Non-domestic consumers: 4.4 MU @ Rs. 4.50/kWh:	19.80
▪ Revenue from saving of power through solar lighting:	
▪ Domestic consumers: 7 MU @ rs. 2.50/kWh:	17.50
▪ Non-domestic consumers: 1.1 MU @ Rs. 4.50/kWh:	4.95
▪ Revenue from service charges for distribution of MSEB supply to non members (domestic): Service charges @ 5% on the revenue of Rs. 82.25 million (supply of 32.9 MU @ Rs. 2.50/kWh).	4.15
▪ Total revenue:	150.61

Basis. The energy consumption for each consumer category and the average current MSEB tariff for each category. (Refer Annexure 4 for detailed estimation)

Other assumptions

Assumptions made concerning distribution costs are given.

The distribution Costs:

- Salaries: of distribution staff on the payroll of the project have been considered. These are increased by 5% every year.
- O & M costs: have been considered for the distribution network.

- Training *charges*. These include;
    - Charges to be paid to MSEB for retaining their distribution staff for one year.
    - Training costs for the O & M personnel have been considered for 5 years.

Commission on revenue. These include the commission paid to the village consumer societies and local technicians for retail level O & M , monitoring and billing collection.

Depreciation: has not been considered since the project funding does not have a loan component.

Viability

As can be seen from the profitability statement that the project would generate a cash surplus of over Rs. 40 million every year, which would make it financially sustainable.

PROJECTED PROFITABILITY STATEMENT

	PROFITABILITY STATEMENT			YEAR 1	2	3	4	5	6	7	8	9	10
	Cane Crushed		TCH	360 0	360 0	360 0	360 0	360 0	360 0	360 0	360 0	360 0	360 0
	bagasse genm		TBH	97 2	97 2	97 2	97 2	97 2	97 2	97 2	97 2	97 2	97 2
	Bagasse used	Season	TBH	75 4	75 4	75 4	75 4	75 4	75 4	75 4	75 4	75 4	75 4
		Off-season	TBH	31 4	31 4	31 4	31 4	31 4	31 4	31 4	31 4	31 4	31 4
	Bagasse Purchased		Million MT	0 04	0 04	0 04	0 04	0 04	0 04	0 04	0 04	0 04	0 04
1	Installed Capacity		MW	32 5	32 5	32 5	32 5	32 5	32 5	32 5	32 5	32 5	32 5
2	Power Produced	Season	MW	28 3	28 3	28 3	28 3	28 3	28 3	28 3	28 3	28 3	28 3
		Off-season		17 5	17 5	17 5	17 5	17 5	17 5	17 5	17 5	17 5	17 5
3	Power for own use	Season	MW	11 5	11 5	11 5	11 5	11 5	11 5	11 5	11 5	11 5	11 5
		Off-season		2 5	2 5	2 5	2 5	2 5	2 5	2 5	2 5	2 5	2 5
4	Power Sold	Season	MW	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8	16 8
		Off-season		15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0
5	Operating period	Season	Days	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0
			Hours	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0
		Off-season	Days	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0	180 0
			Hours	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0	4320 0
6	Plant Load Factor		%	80 0	80 0	80 0	80 0	80 0	80 0	80 0	80 0	80 0	80 0
7	Units Generated	Season	MU	97 9	97 9	97 9	97 9	97 9	97 9	97 9	97 9	97 9	97 9
		Off-season		60 4	60 4	60 4	60 4	60 4	60 4	60 4	60 4	60 4	60 4
			Total	158 3	158 3	158 3	158 3	158 3	158 3	158 3	158 3	158 3	158 3
8	Power Export to Grid	Season	MU	58 2	58 2	58 2	58 2	58 2	58 2	58 2	58 2	58 2	58 2
		Off-season		51 7	51 7	51 7	51 7	51 7	51 7	51 7	51 7	51 7	51 7
			Total	109 9	109 9	109 9	109 9	109 9	109 9	109 9	109 9	109 9	109 9

Project financials

61b

Wheeling+Trans'n Losses		2%	2 2	2 2	2 2	2 2	2 2.	2 2	2 2		2 2		2 2	2 2
Distibution losses		5%	5 5	5 5	5 5	5 5	5 5	5 5	5 5		5 5		5 5	5 5
Own distribution		MU	102 2	102 2	102 2	102 2	102 2	102 2	102 2	102 2	102 2	102 2	102 2	102 2
Power Demand		MU	135 1	135 1	135 1	135 1	135 1	135 1	135 1	135 1	135 1	135 1	135 1	135 1
Power Distributed for MSEB		MU	32 9	32 9	32 9	32 9	32 9	32 9	32 9	32 9	32 9	32 9	32 9	32 9
MSEB Revenue @ Rs 2 50		Rs M	82 2	82 2	82 2	82 2	82 2	82 2	82 2	82 3	82 2	82 3	82 2	82 2
9 Service Income @5% MSEB		Rs M	4 11	4 11	4 11	4 11	4 11	4 11	4 11	4 11	4 11	4 11	4 11	4 11
10 Own Revenue		Rs M	146 5	146 5	146 5	146 5	146 5	146 5	146 5		146 5		146 5	146 5
Total Revenue		Rs M	150 61	150 61	150 61	150 61	150 61	150 61	150 61	4 11	150 61	4 11	150 61	150 61

OPERATING EXPENSES

Stores and Consumables		@0 1/unit	15 8	15 8	15 8	15 8	15 8	15 8	15 8		15 8		15 8	15 8
Repairs and Maintainence			5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0	5 0
Insurance			1 5	1 5	1 5	1 5	1 5	1 5	1 5		1 5		1 5	1 5
Salaries & Wages		Genr	7 0	9 0	9 5	9 9	10 4	10 9	11 5		12 1		12 7	13 3
		Distrb'n	17 3	12 5	12 8	13 1	13 3	11 1	11 4		11 8		12 1	12 4
		Total	24 3	21 5	22 2	23 0	23 8	22 1	22 9		23 8		24 8	25 7
Fuel (@Rs /MT)	250 0	Inhouse	18 7	18 7	18 7	18 7	18 7	18 7	18 7		18 7		18 7	18 7
	500 0	Purcased	18 7	18 7	18 7	18 7	18 7	18 7	18 7	0 0	18 7	0 0	18 7	18 7
		Total	37 3	37 3	37 3	37 3	37 3	37 3	37 3		37 3		37 3	37 3
Administrative Expenses			15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0
Comm to Cons Soc @ 5%			7 5	7 5	7 5	7 5	7 5	7 5	7 5	0 2	7 5	0 2	7 5	7 5
Total Cost of Power Distribution			**106.5**	**103.7**	**104.4**	**105.2**	**105.9**	**104.3**	**105.1**	**20.2**	**106.0**	**20.2**	**106.9**	**107.9**

Project financials													81c
Gross Profit before Int & Deprn		44 1	46 9	46 2	45 4	44 7	46 4	45 5	-16 1	44 6	-16 1	43 7	42 7
Profit before Interest		44 1	46 9	46 2	45 4	44 7	46 4	45 5		44 6		43 7	42 7
Interest													
Term Loan		0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
WC Loan	15%	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7	2 7
Total Cost		109 2	106 4	107.1	107.9	108 6	107 0	107 8	22 9	108 7	22 9	109 6	110 6
Operating Profit		41 4	44 2	43 5	42 7	42 0	43 7	42 8		41 9		41 0	40 0
Profit Before Tax (PBT)		41 4	44 2	43 5	42 7	42 0	43 7	42 8		41 9		41 0	40 0
Tax Liability	35 7%	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0 0		0 0	0 0
Profit After Tax (PAT)		41 4	44 2	43 5	42 7	42 0	43 7	42 8		41 9		41 0	40 0
													423 1
Cash Accruals		41 4	44 2	43 5	42 7	42 0	43 7	42 8		41 9		41 0	40 0
Cost Per Unit for own distribution Rs		1 07	1 04	1 05	1 06	1 06	1 05	1 05	0 22	1 06	0 22	1 07	1 08

6

Project development strategy

Introduction

The approaches proposed to develop the project in its full form and to ensure an organised and smooth implementation of the reforms are briefly presented.

Project strategy

The overall project strategy is to make the entire command area of STKWSSK extending to 63 villages, totally independent in respect of power supply in the area and enable eventual adoption by other competent sugar factories for providing clean and quality power supply in the rural area.

STKWSSK as the owner of the power co-generation and distribution project will execute the project. The consultant entrusted with the job will prepare detailed project report (DPR) for the project including the detailed study of the sugar and by-product plants for finalising the modernization and effluent/wastewater mitigation and recycling systems, the study of the agronomical practices in the command area to devise the detailed plans for water conservation; as well as undertake the detailed engineering of the entire project on approval of the DPR.

STKWSSK, with the assistance from the consultant and guidance from TERI and UNDP-GEF, will organise the project funding as per the plan proposed in the Project Concept.

Simultaneous steps will be taken to obtain the relevant licenses and approvals from the competent authorities.

The steps to build up the institutional framework for the operation of the project will be initiated, specially through arrangements with MSEB for initial

O&M of the distribution network and training of the STKWSSK's distribution personnel.

As an integral component of the institutional mechanism, STKWSSK will start dialogue with the existing network of village level irrigation societies for taking over the retail distribution of power at respective village level and also initiate the formation of village power consumer societies in the rest of the command area. Training of the society staff as well as the self employed technicians for assisting the societies will be organised through arrangements with MSEB for local level customer complaint attendance, meter reading, billing and recovery, etc.

STKWSSK will begin a dialogue, through the medium of these societies and local NGOs and its own agricultural personnel, with the agricultural and domestic consumers for building attitude change, for providing training to them for changes in the agronomical practices to achieve water economy, to agree for metering of their power consumption, timely payment of the energy bills and economical use of the electricity.

NGOs in the area will be involved for consumer training, attitude building for consenscious use of electricity and irrigation water, timely payment of the energy bills, vigilance for transparency in supply and utilisation, etc.

STKWSSK, with association of the consultant, will take steps for ordering of the plant and machinery for the project components on the basis of the detailed specifications drawn by the consultant and vendor appraisal and selection. Similarly, the construction work will be executed through the steps of architectural plans, specifications, contractor selection, supervision and certification. The erection, testing and commissioning of the various physical components of the project will be undertaken with the help of the consultant.

Sugar factory staff who are conversant with power generation can generally handle the project. Since the co-generation boiler, turbo-generator set and power evacuation system are identical to a power plant, key technical personnel will be employed to ensure proper implementation of the project. Enough technical expertise is available for cogeneration and distribution of power The existing junior staff would be utilized as far as possible with some guidance and training

Training of the factory personnel for the O & M of the generation and distribution plants and systems will be organised through the agency of MSEB.

Action learning project (ALP)

The reforms proposed in Chapter 2 will require a marked change over the current scenario in terms of practices, attitudes of the major stake holders, experience and expertise in implementation and sustained operation of the reform processes.

To successfully handle these reforms, it is proposed to implement them in phases during the implementation of the project. The initial phase of the reforms will be undertaken in selected villages as Action Learning Project. (ALP). This ALP will be used to gain a very valuable experience base including identifying hurdles associated with the implementation and devising strategies to overcome them, so that the subsequent phases can be smoothly implemented. Local level NGOs will also be involved in the execution of ALP.

Monitoring and evaluation

An institutional mechanism will be developed and empowered for monitoring and evaluation of the project during the execution phase as well as the dissemination of its benefits during the operation.

35.	Latawade	971	130
36.	Bheldwade	717	1017
37.	Watnar/udgaon	626	984
38.	Khochi	1077	1885
39.	Nagaon	2010	4900
40.	Ladegaon	422	530
41.	Washi	661	650
42.	Kurlup	1200	970
43.	Yelur	1700	2500
44.	Kundalwadi	614	850
45.	Aitavade Khurd	1294	1500
46.	Tandulwadi	900	1215
47.	Karegaon	520	863
48.	Malewadi	560	525
49	Bhaburwadi	1105	832
50.	Koregaon	969	1008
51.	Shigaon	1400	1300
52.	Sagaon	1164	1627
53.	Kande	693	891
54.	Chikhali	598	600
55.	Natoli	508	648
56.	Mangale	1675	2388
57.	Devwadi	507	830
58.	Tanhapude	334	499
59.	Chikurde	1558	1009
60.	Devarde	246	327
61.	Aitavade/Budruk	1160	1550
62.	Karve	390	797
63.	Karanjavade	572	525
Total		**60778**	**87598**
Lift Irrigation (8800 HP)			6565
Total Load			**94163**

Annexure 2. Electrical demand calulation

Sl.No.	Village	Non domestic	Domestic	Agricultural Pump			
		Energy	Energy	Ind.Pump	Lift Irrigatic	Total Ind.P.+L..I,)	Grand Total
1	KODOLI	702720	5723640	5736960		5736960	12163320
2	SHAHAPUR	0	0	0			
3.	KAKHE	90000	662472	398400		398400	1150872
4	MOHAVE	129600	758160	611040		611040	1498800
5	BORPADALI	57600	530640	663840		663840	1252080
6.	ARALE	57600	501120	0		0	558720
7.	SATAVE	158400	764496	276192		276192	1199088
8	AMATEWADI	14400	71712	0		0	86112
9.	SAVARDE	93600	731952	1790112		1790112	2615664
10.	PORLE /	0	412992	0		0	412992
11	KUSHIRE	0	350784	0		0	350784
12.	BAHIREWADI	79200	656640	0		0	735840
13.	POKHALE	79200	328320	0		0	407520
14.	JAKHALE	86400	681844	0		0	768244
15	KEKHALE	79200	764784	1157760		1157760	2001744
16.	MALE	180000	978048	796800		796800	1954848
17.	OLD /	255600	3328632	1848576		1848576	5432808
18.	NILEWADI	54000	337824	515232		515232	907056
19	PADALI	39600	483840	0		0	523440
20.	MANPADALI	97200	925920	398400		398400	1421520
21.	AMBAP	133200	1897776	956160		956160	2987136
22	TALASANDE	115200	1238976	828200		828200	2182376
23.	CHAVARE	122400	724192	594912		594912	1441504
24	SHIYE	92160	1296720	504480		504480	1893360
25.	TOP	0	562464	0		0	562464
26	BHUYEE	97200	616032	430272		430272	1143504
27	GHUNKEE	129600	1278720	0		0	1408320
28	KINI	154800	1313280	0		0	1468080
29.	VATHAR /	104400	1131840	0		0	1236240
30.	BHADOLE	136800	2392416	15936000		15936000	18465216
31	VADGAON	424800	6523200	7171200		7171200	14119200
32	MINCHE	122400	971136	276192		276192	1369728
33	SANARDE /	126000	1578816	435552		435552	2140368

Sl.No.	Village	Non domestic Energy	Domestic Energy	Agricultural Pump Ind.Pump	Lift Irrigatic	Total Ind.P.+L..I.)	Grand Total
34	TASGAON	0	309312	0		0	309312
35	LATAVADE	158400	1239904	2426240		2426240	3824544
36	BHENDWADE	115200	768168	1965120		1965120	2848488
37	VATHAR /	82800	675184	1399728		1399728	2157712
38	KHOCHI	129600	1261728	3984000		3984000	5375328
39	NAGAON	208800	2241864	1418304		1418304	3868968
40.	LADEGAON	0	364608	0		0	364608
41	VASHI	43200	705024	0		0	748224
42.	KURLUP	111600	1323216	2002656		2002656	3437472
43.	YELUR	129600	1038888	5327904		5327904	6496392
44	KUNDALWADI	54000	606816	0		0	660816
45.	AITAVADE	136800	1601856	5577600		5577600	7316256
46.	TANDULWADI	136800	777600	0		0	914400
47	KANEGAON	79200	619200	1035840		1035840	1734240
48.	MALEWADI	28800	483840	0		0	512640
49	BHADURWADI	118800	1100056	2586912		2586912	3805768
50.	KOREGAON	140400	1171008	557760		557760	1869168
51.	SHIGAON	0	1209600	0		0	1209600
52.	SAGAON	151200	1357056	1992000		1992000	3500256
53.	KANDE	0	598752	0		0	598752
54.	CHIKALI	108000	690048	0		0	798048
55.	NATOLI	0	438912	0		0	438912
56.	MANGALE	0	1447200	1949472		1949472	3396672
57.	DEVWADI	82800	438048	0		0	520848
58.	TAHNAPUDE	0	0	0		0	0
59.	CHIKURDE	0	0	0		0	0
60.	DEVARDE	0	0	0		0	0
61.	AITAVDE	126000	1323216	1721088		1721088	3170304
62.	KARVE	50400	3433056	84960		84960	3568416
63.	KARANJAVADE	0	0	0		0	0
64.	LIFT IRRIGATION SCHEME (70)				15755520	15755520	15755520
	Total connected load 8800	5502960	67743548	75355864	15755520	91111384	164382692

Annexure 3. Broad specifications of cogen plant and electrical system

Main plant and equipment

Steam generator and auxiliaries:

The steam generating system for the co-generation plant will consist of two bagasse fired boilers, with a Maximum Continuous Rating (MCR) of 100 TPH, with the outlet steam parameters at 67 ata and 510 Deg C. The combustion system of the boiler shall be travelling grate with spreader stoker. The dust concentration in the flue gases leaving the boiler shall be a maximum of 150 mg/N Cum.

Even though, the major operating fuel is bagasse; in order to meet with any contingent situation, the boiler is also designed to operate with other biomass fuels and imported coal. There will be a brick lining for the entire height of the stack.

Turbogenerators and auxiliaries

In view of the plant operation during the crushing season and off season, it is proposed to go in for two numbers Turbo Alternator sets of 17.5 MW each. One set will be Back Pressure type for providing process steam during the season while the other unit will be Extraction Condensing type. This unit will supply the balance process steam and also generate some power during season through the condensing route.

During off-season operation, this turbo-generator shall only be used to generate 17.5 MW power After meeting the factory maintenance and the co-generation plant auxiliary loads, about 15 MW power will be available for sale to consumers.

The Switchyard and Transmission and Distribution System is described subsequently in this annexure. Also refer Key line diagram in Chapter2: Optimal sizing of cogen plant)

The voltage level of generation will be 11 kV and the exportable power will be stepped up to 33 kV and paralled with the existing MSEB grid at the Kodoli Sub-station, at a distance of about 1 km from the sugar plant. Plant internal consumption will be at 11 kV and 415V, and also to suit the DC drives.

Suitably rated step-down transformers are proposed. Power from the co-generation plant will be stepped down to the desired levels through transformers near the present Power House building and connected to the distribution feeders inside the present Power House This will help avoid any disturbance in the sugar plant operation while commissioning the proposed co-generation plant.

In order to achieve steam economy for maximizing the power generation in the plant, it is proposed to divert all the steam to the power turbines in place of the existing mechanical mill/ fibrizer drive turbines, which are inefficient, being of smaller size. The existing turbine drives for the mills and the fibrizer would be replaced with suitably rated DC motors for the mills and 11 kV AC slip ring induction motor for the fibrizer. Power supply to these motors will be provided through suitably rated step down transformers placed near the Mill House.

The Co-generation power cycle shall be designed with one LP heater (De-aerator) and one High Pressure feed water heater

The complete plant instrumentation and control system shall be based on Distributed Control System (DCS) philosophy, covering the total functioning requirements of measuring, monitoring, alarming and controlling, logging, sequence interlocks and equipment protection etc, as enumerated subsequently in the write-up of the Electrical System.

The fuel (mainly the bagasse and other bio-mass) handling system shall be a combination of belt conveyors and slat chain conveyors.

Bagasse storage

There will be a separate closed storage yard for bagasse for feeding the co-generation plant boilers, with stacking and reclaiming conveyors Suitable fire prevention measures will be taken with adequate ventilation in the covered yard. The stacks will be pyramidal in shape each with a capacity of 1000 MT of bagasse and through-and-through openings for ventilation to prevent any heat build up The stacks will be thatched from top An arrangement to spray boric acid will be installed for preventing deterioration. In addition, a suitably designed fire protection system with high pressure hydrants, valves/actuators and piping will be provided

The ash handling system will be a combination of submerged scrapper conveyor for the grate bottom ash and screw conveyor / belt conveyor handling system for the fly ash.

All the ash will be taken and stored in bins and disposed off in trucks to be used as nutrients in the cane fields or used as solids to the extent possible in the composting plant.

The plant layout shall make optimum use of the land and facilities to minimize the cost. The optimum arrangement of the equipment shall be determined bv the considerations of functional requirements, economy of piping and electrical cables, economy of equipment supports, installation and maintenance access requirements, ventilation requirements and equipment generated noise and vibrations.

Electrical system of the cogeneration plant

Power evacuation

The power available for export from co-generation plant is estimated to be about 15.0 MW after meeting the captive power demands of Sugar Mill and Co-gen Auxiliaries. The entire power will be distributed to the consumers through the KODOLI 33kV sub-station of MSEB.

It is proposed to evacuate this power of 15.0MW through a 33kV double circuit transmission line from the plant 33kV sub-station to the proposed KODOLI 33kV sub-station of MSEB.

Generators

Two numbers synchronous generators in the power plant. The synchronous generators will be rated between 15/17.5MW, 11kV, 0.8 pf(lag), 50Hz, 1500 rpm, with brush-less excitation system, suitable for parallel operation between the generator units and the MSEB grid.

Cooling system

Closed circuit air ventilation system will be provided for removal of heat and control of temperature, of stator and rotor windings

11kv Switchgear

The power generated from the generators will be fed to an Indoor Metal clad 11kV switchgear through cables.

The 11kV switchgear will comprise of

- 2 Nos. incomer feeders, 2 Nos. generator transformer feeders, 5 Nos. auxiliary transformer feeders and a bus coupler - draw out type circuit breaker panel.

- Besides, the 11kV switchgear will also have bus VT modules on either side of bus coupler.
- The breakers will be Vacuum / SF6 type.

Generator transformers

The 11kV switchgear will be connected to generator transformers and will be installed out door in proximity of the power station building. To encounter voltage variations of MSEB grid and for satisfactory operation of the unit, on-load tap changers on the HT side of the transformers, having a voltage range of -10% to +10% in steps of 1.25%, will be provided.

The transformers will be provided with cable box for termination of cables from the 11kV switchgear. The high voltage terminals will be brought out through bushings for connection to outdoor switchyard equipment.

11kV Connection between generator and 11kv switchgear

The connection between generator and 11kV switchgear will be through 11 kV Bus Duct.

SPVT cubicle

The surge protection voltage transformer (SPVT) cubicle will consist of surge protection equipment and voltage transformers The surge protection equipment would comprise of lightning arresters with suitable discharge characteristics to suit the generator insulation level in parallel with suitably rated capacitor for smoothening the rate of rise of Impulse voltage. The SPVT cubicle will be connected by means of a tap off duct from the generator bus duct. The voltage transformer will be single phase, star connected, dry type units with draw out feature.

Neutral grounding resistor (N.G.R.)

The N.G.R. cubicle will consist of suitably rated resistor with isolator. Further, neutral side CT and line side CT, if any, will be mounted in the cubicle. The neutral is formed inside the N.G.R. cubicle.

33 kV Switchyard

The 33kV switchyard will consist of 33kV bus arrangement with incomers from generator transformers and two outgoing feeders for connecting to the 33kV double circuit over head transmission lines from the co-generation power plant to the proposed Kodoli substation.

The fault level at 33kV bus is 26 24kA and Vacuum / SF6 Breakers suitable for this breaking capacity will be provided.

Station/Sugar plant auxiliary power supply arrangement

- Service Transformers
- The total station / sugar plant auxiliary load is indicated below ·
- Process House (boiling) - 5000kW
- Co-generation plant (auxiliary) - 2000kW
- Mill House - 2000kW @ 11 kV 2500kW @ 415V

Each of the above loads will be catered by 100% capacity oil filled outdoor type transformer as indicated below.

415V Switchgear

- The Transformers will be connected to existing 415V PCC switchgear. The 415V switchgear will feed all the sugar plant loads.
- The 415V switchgear will be of metal enclosed non-draw out type with single main bus bar and will be equipped with:
- · Incomers with draw-out type air break circuit breakers / non draw-out moulded case circuit breaker with short circuit, earth fault and overload release.
- Outgoing feeders to switchboards / MCC with moulded case circuit breaker fitted with adjustable magnetic short circuit trip and thermal over load trip.
- Motor feeders with non draw out type starter units fitted with air break contactor, high rupturing capacity (HRC) fuses, *thermal overload releases.*
- The switchgear will be fitted with the necessary current transformers, indicating instruments, lamps, push buttons etc.
- The transformer is directly connected to the D.C. drives and then on to the D.C. motors.

Emergency power system

Diesel generator

A reliable power supply is required for safe shut down of turbines and for certain important plant auxiliaries in the event of failure of AC supply in the station.

The co-generation plant will have DG sets of 625 KVA, 415 Volts, 50Hz, 0.8 PF lag, 3 phase AC Generator.

Direct current supply system

The Direct Current System (DC) is the most reliable source of supply in the power station and will be used for the control and protection of the Power Plant equipment. The DC system will be used for the following :

- Electrical control of equipment and indications on the control panel
- Power supply to the following services in case of total AC power failure
- Communication system
- DC lighting of strategic areas for safe personnel movement.
- The Generator package consists of a 110V DC supply system catering to the above mentioned loads. However, a 110V DC - 300Ah battery bank will be provided for catering to the DC power requirements of 33kV outdoor switchyard.
- The battery sizing will be done to cater to the following type of loads :
    - Momentary load for 1 minute
    - Emergency load for 2 hours
    - Continuous load for 10 hours

Uninterrupted power supply (UPS) system

An uninterrupted power supply system (UPS) of 25kVA capacity will be provided to cater to the 110V AC single phase 50 Hz two wire power supply requirements of the instrumentation and control system.

One battery bank of 110V with associated float and boost chargers and Inverters would be provided to derive uninterrupted 110V AC power supply through suitably rated Inverters. The batteries will be sized to cater to the loads for 30 minutes. This power supply will be used to feed essential services such as control, instrumentation, annunciation etc. requiring UPS power. The type of batteries and charger for the UPS system would be similar to that described above for the DC system.

Control and protection system

Generator

The following protections will be provided :

- Differential protection (87G)
- Stator earth fault protection (51 N)
- Loss of field protection (40)
- Negative phase sequence current protection (46)
- Impedance or voltage restrained over current backup protection (21G/51V)
- Rotor earth fault protection (64R)
- Reverse power protection (32)

- Over voltage protection (59)
- Under voltage protection (27)
- Overload alarm (50G)

Generator transformer

- Differential protection (87GT)
- Directional over current (67)
- Directional Earth fault current (67N)
- Restricted earth fault (64GT)
- Buchholz oil and winding temperature alarm / trip (63B / 49WT / 49 OT

33kV Switchyard (33 kV Lines)

- Over current relay with high set instantaneous unit (51 / 50)
- Over current earth fault relay with high set instantaneous unit (51N / 50N)

Synchronising scheme

- Auto synchronizers / manual synchronizing scheme consisting of double voltmeter / double frequency meter / synchronizer will be provided. Also in the manual synchronizing mode, closure of breaker is done only under check synchronizing permissive conditions. Besides, provision is also made for dead line / dead bus closing of the circuit breakers.

Lighting

The Co-generation power plant lighting system would comprise the following:

- Normal 240V AC Lighting System
- The lighting circuit in the normal 240V AC lighting system would be fed through 415 / 433 volts, 3 phase, 4 wire lighting transformer connected to a 415V distribution system
- Direct current emergency lighting System
- Direct current emergency lights would be provided at strategic points in the power station viz., near entrances, staircases, the main control room etc.
- These would be fed from the station 110V DC system and would be off when the normal AC power supply is available. These would be automatically switched on when the normal AC supply fails.

Cabling

All cables will be selected to carry the load current under site conditions, with permissible voltage drop. In addition, high voltage cables would be sized to withstand the short circuit current. The following types of cables would be used

For 11kV system· 11kV unearthed grade, single / multi core, stranded aluminium conductor, cross linked polyethylene insulated, screened, aluminium wire / galvanized steel wire armoured and over all PVC sheathed cables conforming to IS 7098 - Part - II.

For medium voltage and low voltage power cables: 650 / 1100V grade stranded aluminium conductor, HR PVC / PVC insulated, colour coded, PVC sheathed and aluminium wire / galvanized steel wire armoured overall PVC sheathed cables conforming to IS - 1554.

Control, protection, signalling and supervisory cables would be of 650 / 1100V grade, annealed high conductivity stranded copper conductor, PVC / elastomer insulated and overall PVC / elastomer sheathed, signalling and supervisory cables would be in twisted pairs and screened wherever required.

The inner and outer sheaths of all the above cables would have flame retardant capabilities. Cables would be laid in steel ladder type cable trays. In outdoor areas, cables will be laid in racks / built-up trenches or will be buried directly underground.

Lightning protection system

A lightning protection system will be provided as per IS 2309 The protections will consist of roof conductors, air terminals and down comers and will be provided for tall structures.

Fire alarm system

A fire alarm system will be installed to provide visual and audible alarm in the power station for fire detection. This system will comprise manual call points located at strategic location in areas which are normally manned and automatic smoke and heat detectors located at important points such as the cable vault, the control room, the switchgear room etc. to detect fire at an early stage and provide visual and audible alarm.

Communication system

For effective communication in the plant, P & T communication facility provided in sugar plant is also extended to co-generation plant for external communication Similarly public address and PABX facility is also extended to co-generation plant

Safety earthing and lightning protection system

A safety earthing system comprising of a buried mild steel conductor-earthing grid should be provided for switchyard and other areas. This would be connected to the earth grids in various buildings The buried earth grids would be further connected to earthing electrodes The earthing connection of individual equipment to the earthing grid would be by galvanized steel strips for the exposed portion and by mild steel strips for the buried portion. The selection of earth conductor sizes would be based on the applicable fault levels

A lightning protection system comprising of roof conductors, vertical air termination and down comers should be provided for those structures whose calculated risk index indicates that protection is required.

Instrumentation and control system

It is envisaged to provide a comprehensive, integrated instrumentation and control system that will ensure safe, reliable and efficient operation of the power plant. A centralised control system together with supervisory control and data acquisition package will be able to achieve the complete operational control of the power plant as well as take care of energy management and management information system.

- The built in features of a centralised control system will have complete control capabilities that include closed-loop controls, open-loop controls, communication, annunciation, interfacing, data acquisition, data logging, data storage and retrieval, graphic displays and trends.
- The complete functional control is achieved by the following sub systems:
  - Data acquisition, display and logging sub-system
  - Start / stop sequence and interlock sub-system
  - Closed loop control sub-system for critical operational parameters of the power plant
  - Engineering / operating interface sub-system for setting / changing operational parameters for different situations
  - Communication sub-system for inter-connecting all the above systems
  - Data highway and network for connecting the control and data acquisition sub-systems, operator interface sub-systems to a duplexed data highway to facilitate information exchange among all system users.

Boilers and auxiliaries

The basic instrumentation and microprocessor controller will take care of complete Boiler operation. Following critical parameters will be controlled by the above system for safe and effective operation;

- Drum level control (three element feed water regulator)
- Auto combustion control
- Auto ae-aerator temperature control
- De-aerator level control
- De-aerator pressure control
- Furnace draft pressure control
- Superheated steam temperature control
- Fuel feed control
- Blow down tank level control
- Soot blower control
- For monitoring / interlocking, the central control system will access signals from the following systems / equipment after installing suitable interfacing devices
    - Boiler safety and protection interlocks
    - Boiler feed pumps and transfer pumps
    - Super heaters and economizer
    - Chemical dosing
    - Flame control system
    - Bagasse handling system
    - Ash handling system
    - DM water system
    - PRDS
    - Cooling water system

Turbines and auxiliaries

- The Steam turbines will be provided with electronic governors, programmable microprocessor based, digital control and capable of operating in parallel with the SEB grid and other TG sets.
- The alternators have been provided with automatic voltage regulators, capable of running the alternators in parallel with each other and the SEB grid. The AVR panel will also have Auto PF controller The above controllers, integrated in a PLC system with supervisory control and data acquisition package, complete the turbines and auxiliaries control system as planned
- The central control system proposes to control the following functions by transferring the signals from the PLC system through suitable interfacing equipment

- Lube oil control
- Control oil
- Gland sealing steam control
- Condenser hot-well level control
- Turbine protection and safety interlocks
- Turbine start-up and stopping sequence
- Generator cooling system

Following signals are to be accessed for interlocking / data logging at central control system

- AOP, EOP, MOP, CEP status
- Bearing temperatures
- Instrument air system

Electrical system

The Electrical System is provided with Conventional Relay and Protective systems along with a Synchronizing panel suitable for synchronizing with SEB grid & other generating units. The above features will be integrated into a PLC system for control, monitoring and data acquisition

- The central control system will transfer the following signals through suitable interfacing equipment for control / interlocking purposes
- Protective relay status in power plant and switchyard.
- Circuit breakers status in power plant and switchyard.
- Synchronization parameters
- Signals from MCC's
- Signals from transducers.
- The following signals will be used for monitoring and data Acquisition at the central control system·
  - Generated voltage, current, kilowatt, kVAR, power factor,
  - Frequency, kWH, kVARH, kVAH.
  - Line voltage, current, kilowatt, kVAR, power factor, frequency,
  - kWH, kVARH, kVAH.
  - With the above monitoring, control and data acquisition system in place, the cogen plant operation and maintenance will be smooth, reliable and systematic.

Power evacuation

A double circuit 33kV transmission line is proposed between the power plant 33kV switchyard and Kodoli sub-station, which is about 1 km from the power plant. This double circuit transmission line is terminated on to the 33kV bus of the Kodoli sub-station and the 33kV incomes from Vathar sub-station is retained In case of any problems in evacuating the power from the power plant, then the power could be drawn from MSEB grid and distributed to the consumers One 33 kV feeder from the power plant switchyard is also proposed for feeding to the power the paper plant.

Annxure 4. Revenue calculations for sale of power

Sl. No.	Village	Domestic			Non Domestic			Television			Radio		
		Energy Consumed Units	Rate In Rs.	Total Revenue In Rs.	Energy Consumed - Units	Rate in Rs.	Total Revenue in Rs.	Energy Consumed - Units	Rate In Rs.	Total Revenue In Rs	Energy Consumed - Units	Rate in Rs.	Total Revenue In Rs.
1	KODOLI	3810240	2.50	9525600.00	702720	4.60	3232512.00	227520	2.50	568800.00	649080	2.50	1622700.00
2.	SHAHAPUR	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
3.	KAKHE	499392	2.50	1248480.00	90000	4.60	414000.00	77760	2.50	194400.00	50760	2.50	126900.00
4.	MOHAVE	587520	2.50	1468800.00	129600	4.60	596160.00	86400	2.50	216000.00	32400	2.50	81000.00
5.	BORPADALI	412128	2.50	1030320.00	57600	4.50	259200.00	36000	2.50	90000.00	23760	2.50	59400.00
6.	ARALE	501120	2.50	1252800.00	57600	4.50	259200.00	0	0.00	0.00	0	0.00	0.00
7.	SATAVE	562464	2.50	1406160.00	158400	4.50	712800.00	48672	2.50	121680.00	32400	2.50	81000.00
8.	AMATEWADI	71712	0.75	53784.00	14400	4.60	66240.00	0	0.00	0.00	0	0.00	0.00
9.	SAVARDE BACCHE	527904	2.50	1319760.00	93600	4.60	430560.00	85248	2.50	213120.00	32400	2.50	81000.00
10.	PORLE / THANE	412992	2.50	1032480.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
11.	KUSHIRE	350784	2.50	876960.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
12.	BAHIREWADI	656640	2.50	1641600.00	79200	4.60	364320.00	0	0.00	0.00	0	0.00	0.00
13	POKHALE	328320	2.50	820800.00	79200	4.60	364320.00	0	0.00	0.00	0	0.00	0.00
14	JAKHALE	571968	2.50	1429920.00	86400	4.60	397440.00	30816	2.50	77040.00	54864	2.50	137160.00
15	KEKHALE	510624	2.50	1276560.00	79200	4.60	364320.00	92160	2.50	230400.00	75600	2.50	189000.00
16.	MALE	710208	2.50	1775520.00	180000	4.60	828000.00	86400	2.50	216000.00	43200	2.50	108000.00
17.	OLD / PARAGAON	1790208	2.50	4475520.00	255600	4.60	1175760.00	187776	2.50	469440.00	262008	2.50	655020.00
18.	NILEWADI	250560	2.50	626400.00	54000	4.60	248400.00	25056	2.50	62640.00	24192	2.50	60480.00
19.	PADALI	483840	2.50	1209600.00	39600	4.60	182160.00	0	0.00	0.00	0	0.00	0.00
20.	MANPADALI	743040	2.50	1857600.00	97200	4.60	447120.00	57600	2.50	144000.00	108000	2.50	270000.00
21.	AMBAP	1381536	2.50	3453840.00	133200	4.60	612720.00	172800	2.50	432000.00	205200	2.50	513000.00
22.	TALASANDE	736128	2.50	1840320.00	115200	4.60	529920.00	237600	2.50	594000.00	133920	2.50	334800.00
23.	CHAVARE	475072	2.50	1187680.00	122400	4.60	663040.00	72000	2.50	180000.00	108000	2.50	270000.00
24.	SHIYE	997056	2.50	2492640.00	92160	4.60	423936.00	118656	2.50	296640.00	146448	2.50	366120.00
25.	TOP	562464	2.50	1406160.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
26.	BHUYEE	616032	2.50	1540080.00	97200	4.60	447120.00	0	0.00	0.00	0	0.00	0.00
27.	GHUNKEE	1278720	2.50	3196800.00	129600	4.60	596160.00	0	0.00	0.00	0	0.00	0.00
28.	KINI	1313280	2.50	3283200.00	154800	4.60	712080.00	0	0.00	0.00	0	0.00	0.00
29.	VATHAR / VADGON	1131840	2.50	2829600.00	104400	4.60	480240.00	0	0.00	0.00	0	0.00	0.00

30	BHADOLE	1571616	2 50	3929040.00	136800	4 60	629280.00	259200	2.50	648000.00	216000	2.50	540000.00
31	VADGAON	4147200	2.50	10368000 00	424800	4 60	1954080.00	432000	2 50	1080000.00	43200	2 50	108000.00
32	MINCHE	760320	2 50	1900800.00	122400	4 60	563040.00	86400	2.50	216000.00	86400	2 50	216000.00
33	SANARDE / MINCHE	1041984	2 50	2604960 00	126000	4 60	573600.00	204192	2 50	510480.00	194400	2 50	486000.00
34	TASGAON	309312	2 50	773280 00	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00
35	LATAVADE	838944	2 50	2097360 00	158400	4 60	728640.00	243360	2 50	608400.00	54000	2.50	135000.00
36	BHENDWADE	619488	2 50	1548720 00	115200	4 60	529920.00	46080	2.50	115200.00	16200	2.50	40500.00
37.	VATHAR / UDAGAON	540864	2 50	1352160.00	82800	4.60	380880.00	61528	2.50	153820.00	24408	2.50	61020 00
38	KHOCHI	930528	2 50	2326320.00	129600	4 60	596160.00	115200	2 50	288000.00	129600	2.50	324000 00
39	NAGAON	1736640	2 50	4341600.00	208800	4.60	960480.00	258336	2 50	645840.00	246888	2 50	617220 00
40	LADEGAON	364608	2 50	911520.00	0	0 00	0.00	0	0 00	0.00	0	0.00	0.00
41	VASHI	571104	2 50	1427760.00	43200	4.60	198720.00	69120	2 50	172800.00	64800	2.50	162000.00
42	KURLUP	1114560	2 50	2786400 00	111600	4 60	513360.00	64800	2 50	162000.00	5616	2 50	14040.00
43	YELUR	530496	2.50	1326240 00	129600	4.60	596160.00	79200	2.50	198000.00	42120	2.50	105300.00
44	KUNDALWADI	530496	2 50	1326240 00	54000	4 60	248400.00	43488	2 50	108720.00	32832	2.50	82080.00
45	AITAVADE	1118016	2.50	2795040 00	136800	4 60	629280.00	172800	2 50	432000.00	172800	2 50	432000.00
46	TANDULWADI	777600	2 50	1944000.00	136800	4 60	629280.00	0	0.00	0.00	0	0 00	0.00
47	KANEGAON	449280	2 50	1123200 00	79200	4 60	364320.00	66240	2 50	165600.00	17280	2 50	43200 00
48	MALEWADI	483840	2 50	1209600 00	28800	4 60	132480.00	0	0 00	0.00	0	0 00	0.00
49	BHADURWADI	454720	2 50	1136800.00	118800	4 60	546480.00	161280	2.50	403200.00	48600	2 50	121500.00
50	KOREGAON	837216	2 50	2093040.00	140400	4 60	645840.00	201600	2 50	504000.00	108000	2 50	270000.00
51	SHIGAON	1209600	2 50	3024000.00	0	0.00	0.00	0	0.00	0.00	0	0 00	0 00
52.	SAGAON	1005696	2 50	2514240 00	151200	4.60	695520.00	152640	2 50	381600.00	129600	2.50	324000.00
53	KANDE	598752	2 50	1496880.00	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00
54	CHIKALI	516672	2 50	1291680.00	108000	4.60	496800.00	78336	2 50	195840.00	8640	2 50	21600.00
55	NATOLI.	438912	2 50	1097280.00	0	0 00	0.00	0	0 00	0.00	0	0.00	0 00
56	MANGALE	1447200	2 50	3618000 00	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00
57	DEVWADI	438048	2 50	1095120.00	82800	0 00	0.00	0	0 00	0 00	0	0 00	0.00
58	TAHNAPUDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00	0	0 00	0.00
59	CHIKURDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
60	DEVARDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
61	AITAVDE	1002240	2 50	2505600.00	126000	4 60	579600.00	116640	2 50	291600.00	45360	2 50	113400.00
62.	KARVE	3366960	2 50	8417400.00	50400	4 60	231840.00	25920	2 50	64800.00	9072	2 50	22680.00
63	KARANJAVADE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
64.	LIFT IRRIGATION SCHEME (70) Total connected load 8800 HP												
65	Total	52026704	143 25	129941264 00	5502960	220.50	28137888.00	######	92 50	11452060.00	3678048	92 50	9195120 00

Annxure 4. Revenue calculations for sale of power

l. .o.	Village	Fridge			Agriculture Pumps					
					3 HP			5 HP		
		Energy Consumed - Units	Rate in Rs.	Total Revenue in Rs.	Energy Consumed - Units	Flat Rate	Total Revenue in Rs.	Energy Consumed - Units	Flat Rate	Total Revenue in Rs.
	KODOLI	1036800	2 50	2592000.00	1900800	Rs 75 / HP / Month	972000.00	3836160	Rs.75 / HP / Month	1620000.00
	SHAHAPUR	0	0.00	0.00			0.00			0 00
	KAKHE	34560	2.50	86400.00	132000	. .	67500.00	266400	. . .	112500.00
	MOHAVE	51840	2 50	129600.00	184800	. . .	94500.00	426240	. . .	180000.00
	BORPADALI	58752	2.50	146880.00	237600	. . .	121500.00	426240	. . .	180000.00
	ARALE	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
	SATAVE	120960	2.50	302400.00	95040	Rs.75 / HP / Month	48600.00	181152	Rs.75 / HP / Month	76500.00
	AMATEWADI	0	0.00	0.00	0	0.00	0.00	0	0 00	0.00
	SAVARDE BACCHE	86400.	2.50	216000.00	596640	Rs 75 / HP / Month	305100.00	1193472	Rs 75 / HP / Month	504000.00
	PORLE / THANE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
1.	KUSHIRE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
2	BAHIREWADI	0	0 00	0.00	0	0 00	0.00	0	0.00	0.00
3	POKHALE	0	0 00	0.00	0	0 00	0.00	0	0.00	0.00
	JAKHALE	24196	2,50	60490.00	0	0 00	0.00	0	0 00	0.00
	KEKHALE	86400	2.50	216000.00	411840	Rs.75 / HP / Month	210600.00	745920	Rs.75 / HP / Month	315000.00
	MALE	138240	2.50	345600.00	264000	. . .	135000.00	532800	. . .	225000.00
7	OLD / PARAGAON	1088640	2.50	2721600.00	612480	. . .	313200.00	1236096	. . .	522000.00
	NILEWADI	38016	2.50	95040.00	174240	. . .	89100.00	340992	. . .	144000.00
	PADALI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
	MANPADALI	17280	2 50	43200.00	132000	Rs.75 / HP / Month	67500.00	266400	Rs.75 / HP / Month	112500.00
	AMBAP	138240	2.50	345600.00	316800	. . .	162000.00	639360	. . .	270000.00
	TALASANDE	131328	2.50	328320.00	290400	. . .	148500.00	537800	. . .	225000.00
	CHAVARE	69120	2.50	172800.00	200640	. . .	102600.00	394272	. . .	166500.00
	SHIYE	34560	2.50	86400.00	184800	. . .	94500.00	319680	. . .	135000.00

25	TOP	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
26	BHUYEE	0	0.00	0.00	142560	Rs 75 / HP / Month	72900.00	287712	Rs 75 / HP / Month	121500.00
27	GHUNKEE	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
28	KINI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
29	VATHAR / VADGON	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
30	BHADOLE	345600	2.50	864000.00	5280000	Rs 75 / HP / Month	2700000.00	10656000	Rs 75 / HP / Month	4500000.00
31	VADGAON	1900800	2.50	4752000.00	2376000	"	1215000.00	4795200	"	2025000.00
32	MINCHE	38016	2.50	95040.00	95040	"	48600.00	181152	"	76500.00
33	SANARDE / MINCHE	138240	2.50	345600.00	147840	"	75600	287712	"	121500.00
34.	TASGAON	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
35	LATAVADE	103600	2.50	259000.00	135200	Rs.75 / HP / Month	580500.00	2291040	Rs 75 / HP / Month	967500.00
36	BHENDWADE	86400	2.50	216000.00	686400	"	351000.00	1278720	"	540000.00
37	VATHAR / UDAGAON	48384	2.50	120960.00	462000	"	237600.00	937728	"	120960.00
38	KHOCHI	86400	2.50	216000.00	1320000	"	675000.00	2664000	"	1125000.00
39	NAGAON	0	0.00	0.00	469920	"	240300.00	948384	"	400500.00
40	LADEGAON	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
41	VASHI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
42	KURLUP	138240	2.50	345600.00	660000	Rs.75 / HP / Month	337500.00	1342656	"	567000.00
43	YELUR	387072	2.50	967680.00	1768800	"	904500.00	3559104	"	1503000.00
44	KUNDALWADI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
45	AITAVADE	138240	2.50	345600.00	1848000	Rs 75 / HP / Month	945000.00	3729600	Rs 75 / HP / Month	1575000.00
46	TANDULWADI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
47	KANEGAON	86400	2.50	216000.00	343200	Rs 75 / HP / Month	175500.00	692640	Rs 75 / HP / Month	292500.00
48	MALEWADI	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
49	BHADURWADI	435456	2.50	1088640.00	860640	Rs.75 / HP / Month	440100.00	1726272	Rs 75 / HP / Month	729000.00
50	KOREGAON	24192	2.50	60480.00	184800	"	94500.00	372960	"	157500.00
51.	SHIGAON	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
52	SAGAON	69120	2.50	172800.00	660000	Rs 75 / HP / Month	337500	1332000	Rs 75 / HP / Month	562500.00

53	KANDE	0	0.00	0.00	0	0.00	0.00	0	0 00	0.00
54	CHIKALI	86400	2 50	216000.00	0	0.00	0.00	0	0 00	0.00
55	NATOLI	0	0 00	0 00	0	0 00	0.00	0	0 00	0.00
56	MANGALE	0	0 00	0.00	649440	Rs 75 / HP / Month	332100.00	1300032	Rs 75 / HP / Month	549000.
57	DEVWADI	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
58	TAHNAPUDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0.00
59	CHIKURDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00
60	DEVARDE	0	0 00	0.00	0	0 00	0.00	0	0 00	0 00
61	AITAVDE	158976	2 50	397440.00	570240	Rs 75 / HP / Month	291600.00	1150848	Rs 75 / HP / Month	486000.00
62	KARVE	31104	2 50	77760.00	31680	Rs.75 / HP / Month	16200.00	53280	Rs 75 / HP / Month	22500 00
63.	KARANJAVADE	0	0.00	0.00	0	0.00	0.00	0	0 00	0 00
64.	LIFT IRRIGATION SCHEME (70) Total connected load 8800 HP									
65	Total	7457972	85.00	18644930 00	24425840	0.00	12590100 00	50930024	0 00	20681460 00

Annxure 4. Revenue calculations for sale of power

Sl. No.	Village	Others			Total Energy consumed per annum in Units	Total revenue per annum in Rs.
		Energy Consumed - Units	Rate in Rs.	Total Revenue in Rs.		
1	KODOLI	0	0	0	10262522.5	20133612
2.	SHAHAPUR		2.5	0	0	0
3	KAKHE	0	0	0	1018874 5	2250180
4.	MOHAVE	0	0	0	1314002.5	2766060
5.	BORPADALI	0	0	0	1014482 5	1887300
6	ARALE	0	0	0	558720	1512000
7	SATAVE	0	0	0	1104050 5	2749140
8.	AMATEWADI	0	0	0	86112	120024
9	SAVARDE BACCHE	0	0	0	2019026.5	3069540
10.	PORLE / THANE	0	0	0	412992	1032480
11.	KUSHIRE	0	0	0	350784	876960
12.	BAHIREWADI	0	0	0	735840	2005920
13.	POKHALE	0	0	0	407520	1185120
14	JAKHALE	0	0	0	768246 5	2102050
15:	KEKHALE	0	0	0	1589906.5	2801880
16.	MALE	0	0	0	1690850 5	3633120
17.	OLD / PARAGAON	0	0	0	4820330 5	10332540
18.	NILEWADI	0	0	0	732818.5	1326060
19.	PADALI	0	0	0	523440	1391760
20.	MANPADALI	0	0	0	1289522.5	2941920
21.	AMBAP	0	0	0	2670338.5	5789160
22.	TALASANDE	0	0	0	1891978.5	4000860
23.	CHAVARE	0	0	0	1240866.5	2642620
24	SHIYE	0	0	0	1708562.5	3895236
25	TOP	0	0	0	562464	1406160
26.	BHUYEE	0	0	0	1000944	2181600
27	GHUNKEE	0	0	0	1408320	3792960
28	KINI	0	0	0	1468080	3995280
29.	VATHAR / VADGON	0	0	0	1236240	3309840
30.	BHADOLE	0	0	0	13185218.5	13810320
31.	VADGAON	0	0	0	11743202.5	21502080
32.	MINCHE	0	0	0	1274690 5	3115980
33	SANARDE / MINCHE	0	0	0	1992530.5	4723740
34	TASGAON	0	0	0	309312	773280
35	LATAVADE	0	0	0	3689346.5	5376400
36.	BHENDWADE	0	0	0	2162090.5	3341340
37	VATHAR / UDAGAON	0	0	0	1695714 5	2427400
38.	KHOCHI	0	0	0	4055330.5	5550480
39.	NAGAON	0	0	0	3399048	7205940
40	LADEGAON	0	0	0	364608	911520
41.	VASHI	0	0	0	748224	1961280

42.	KURLUP	0	0	0	2777474.5	4725900
43	YELUR	0	0	0	4727594.5	5600880
44.	KUNDALWADI	0	0	0	660816	1765440
45.	AITAVADE		2.5	0	5468258.5	7153920
46	TANDULWADI	0	0	0	914400	2573280
47	KANEGAON	0	0	0	1391042.5	2380320
48	MALEWADI	0	0	0	512640	1342080
49	BHADURWADI	0	0	0	2945130.5	4465720
50	KOREGAON	0	0	0	1684370.5	3825360
51	SHIGAON	0	0	0	1209600	3024000
52	SAGAON		2.5	0	2840258.5	4988160
53	KANDE	0	0	0	598752	1496880
54	CHIKALI	0	0	0	798050.5	2221920
55	NATOLI	0	0	0	438912	1097280
56	MANGALE	0	0	0	2747232	4499100
57	DEVWADI	0	0	0	520848	1095120
58	TAHNAPUDE	0	0	0	0	0
59	CHIKURDE	0	0	0	0	0
60	DEVARDE	0	0	0	0	0
61	AITAVDE	0	0	0	2600066.5	4665240
62	KARVE	0	0	0	3536738.5	8853180
63	KARANJAVADE	0	0	0	0	0
64.	LIFT IRRIGATION SCHEME (70) Total connected load 8800 HP	15755520	0.74	11659084.8	15755520	11659084.8
65	Total	15755520		0	164382692	231604922